DANA

Instruction Manual

980448

MODEL 8020B ELECTRONIC COUNTER

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_09496

Publication
980448

INSTRUCTION MANUAL

MODEL 8020B

ELECTRONIC COUNTER

DANA LABORATORIES, INC.
2401 CAMPUS DRIVE
IRVINE, CALIFORNIA 92664

DANA®

TELEPHONE (714) 833-1234
TELETYPE 910-595-1136
TELEX 678-341

January 1972

Warranty

Within one year of purchase, Dana Laboratories will repair or replace, at our option, your instrument if in any way it is defective in material or workmanship. All parts and labor charges will be paid by Dana Laboratories. Just return the instrument to your nearest authorized Dana Service Center freight prepaid. We will return it to you freight prepaid.

DANA

TABLE OF CONTENTS

Section	Title	Page
1	INTRODUCTION	1-1
1.1	Scope	1-1
1.3	General Description	1-1
1.5	Block Diagram Description	1-1
1.21	Measurement Modes	1-5
1.23	Totalize Mode	1-5
1.27	Period Mode	1-6
1.30	Period Average Mode	1-6
1.33	Frequency Measurements to 150 MHz	1-7
1.37	Frequency C Mode (to 500 MHz)	1-8
1.40	A/B Ratio Mode	1-8
1.43	Time Interval Mode	1-8
1.46	Time Interval Average	1-9
1.48	Self-Check Mode	1-9
1.50	Specifications	1-9
2	INSTALLATION	2-1
2.1	Unpacking and Inspection	2-1
2.2	Power Connection	2-1
2.3	Fuse	2-1
3	OPERATION	3-1
3.1	Controls	3-1
4	THEORY OF OPERATION	4-1
4.1	General	4-1
4.4	Functional Block Description	4-1
5	PERFORMANCE CHECK & CALIBRATION	5-1
5.1	Introduction	5-1
5.9	Counting Decades and Multiplier/Time Base Decades	5-3
5.10	Decimal Point Logic and Units Logic	5-4
5.11	Input Controls and Marker	5-9
5.12	Frequency Response and Sensitivity	5-10
5.13	Pulse Operation	5-11
5.14	Totalize	5-12

TABLE OF CONTENTS (Continued)

Section	Title	Page
5.15	Period and Period Average	5-12
5.16	A/B (Ratio)	5-13
5.17	Time Interval and Time Interval Averaging	5-14
5.18	Display Time and Gate Output	5-15
5.19	Recorder Output	5-15
5.20	Remote Programming	5-16
5.21	Calibration	5-17
5.22	Signal Conditioning Module	5-17
5.23	500 MHz Prescaler	5-18
6	REMOTE PROGRAMMING AND BCD OUTPUT	6-1
6.1	Remote Programming	6-1
6.9	BCD Output	6-2
7	DRAWINGS	7-1
7.1	Drawings	7-1

SECTION 1

INTRODUCTION

1.1 SCOPE.

1.2 This manual contains installation, operation, and maintenance instructions for the Dana Series 8000B electronic counters (figure 1.1). All models and optional features are covered; therefore, all descriptions may not apply to a particular instrument.

1.3 GENERAL DESCRIPTION.

1.4 The 8000B Series includes five different models, each self-contained for its intended range of applications. No external or plug-in accessories are required. All models have a minimum of four measurement modes: Frequency, Period, Multiple Period Average, and Totalize. Additional measurement modes of Time Interval, Time Interval Average, and Frequency Ratio are available in certain models. All models operate at frequencies up to 150 MHz. Certain models operate at RF frequencies. The capability of each model is shown in table 1.1.

1.5 BLOCK DIAGRAM DESCRIPTION.

1.6 A basic block diagram of the instrument is shown in figure 1.2.

1.7 Input channels A and B are identical through the attenuator and signal conditioning amplifiers. The input is routed through the BNC input connectors and through the AC/DC coupling switch to the attenuator. The attenuator has three positions: X1 range, X10 range, and X100 range. The attenuator output is applied to the signal conditioning amplifier through an overload circuit that protects the circuitry if an "overload" voltage is applied.

1.8 The signal conditioning amplifier is a low-drift dc-coupled Schmitt trigger circuit. Any point on the input waveform can be selected to trigger the Schmitt circuit by front panel controls: the +/− switch selects either positive or negative slope and the INPUT CONTROLS select the amplitude. Output pulses generated by the Schmitt trigger circuit are applied to the Steering Logic and to the Marker Generator.

1.9 The Marker Generator provides a marker pulse used to intensity-modulate an oscilloscope display. The marker pulse is applied to the input connector. It starts when channel A triggers and terminates when channel B triggers. The pulse represents a precise measurement of the time between the two channels' trigger levels and enables accurate

(Picture Not Available)

Figure 1.1 - Model 8035B Electronic Counter

Table 1.1 - Measurement Capability — 8000B Series
Measurement Mode

Model	Totalize	Period	Multiple Period Average	Freq. To 150 MHz	Freq. To 500 MHz	Freq. Ratio	Time Interval		Time Interval Average
							10 ns	100 ns	
8010B	X	X	X	X		X		X	X
8015B	X	X	X	X		X	X		
8020B	X	X	X	X	X				
8030B	X	X	X	X	X	X		X	X
8035B	X	X	X	X	X	X	X		

adjustment of the time interval between the two points.

1.10 An input to channel C is applied directly to the Prescaler that contains a voltage-controlled attenuator (VCA), RF amplifier, and high frequency dividers. The dividers scale the input frequency by a factor of four. This is necessary to reduce the frequency to that acceptable by the digital counters. The VCA and RF amplifiers combine to provide automatic ranging over input amplitude variations of 60 dB throughout the operating frequency.

1.11 The Reference Control Network receives a reference frequency from either the internal reference oscillator or from the External Reference input. External reference inputs of 5 MHz and 10 MHz are buffered, amplified, and applied to a Schmitt trigger circuit to produce harmonics at 10 MHz. A filter rejects frequencies other than 10 MHz. If the external reference signal is large enough to operate the counter, a detector closes a logic gate disconnecting the internal oscillator. The reference signal, passed on to the digital logic section, serves several purposes, one of which is to provide a 10 MHz reference signal to the rear panel.

1.12 Steering Logic routes the inputs to the proper set of decades corresponding to the selected operating mode of the instrument. It "steers" the inputs upon commands from the FUNCTION switch.

1.13 Control signals to the Executive Logic Section are generated by logic in the following blocks in figure 1.2: Multiplier/Time Base (M/TB) Decades, Control Logic, and Gating Logic. The M/TB Decades consist of eight TTL decade counters which, together with Control Logic, Gating Logic, inputs from the Steering Logic, M/TB switches on front panel, and the function switch, control operation of the Executive Logic. The circuits combine to perform the functions listed in table 1.2 for each operating mode. The M/TB Decades supply a scaled output to a rear panel connector. The output is 1/10N x input frequency, where N is the Multiplier setting on the front panel.

1.14 The M/TB switch and the FUNCTION switch operate in conjunction with the Control Logic, Decimal Point Logic, and Units Logic to provide proper annunciators and decimal point locations. They also control other logic contributing to the functions listed in table 1.2.

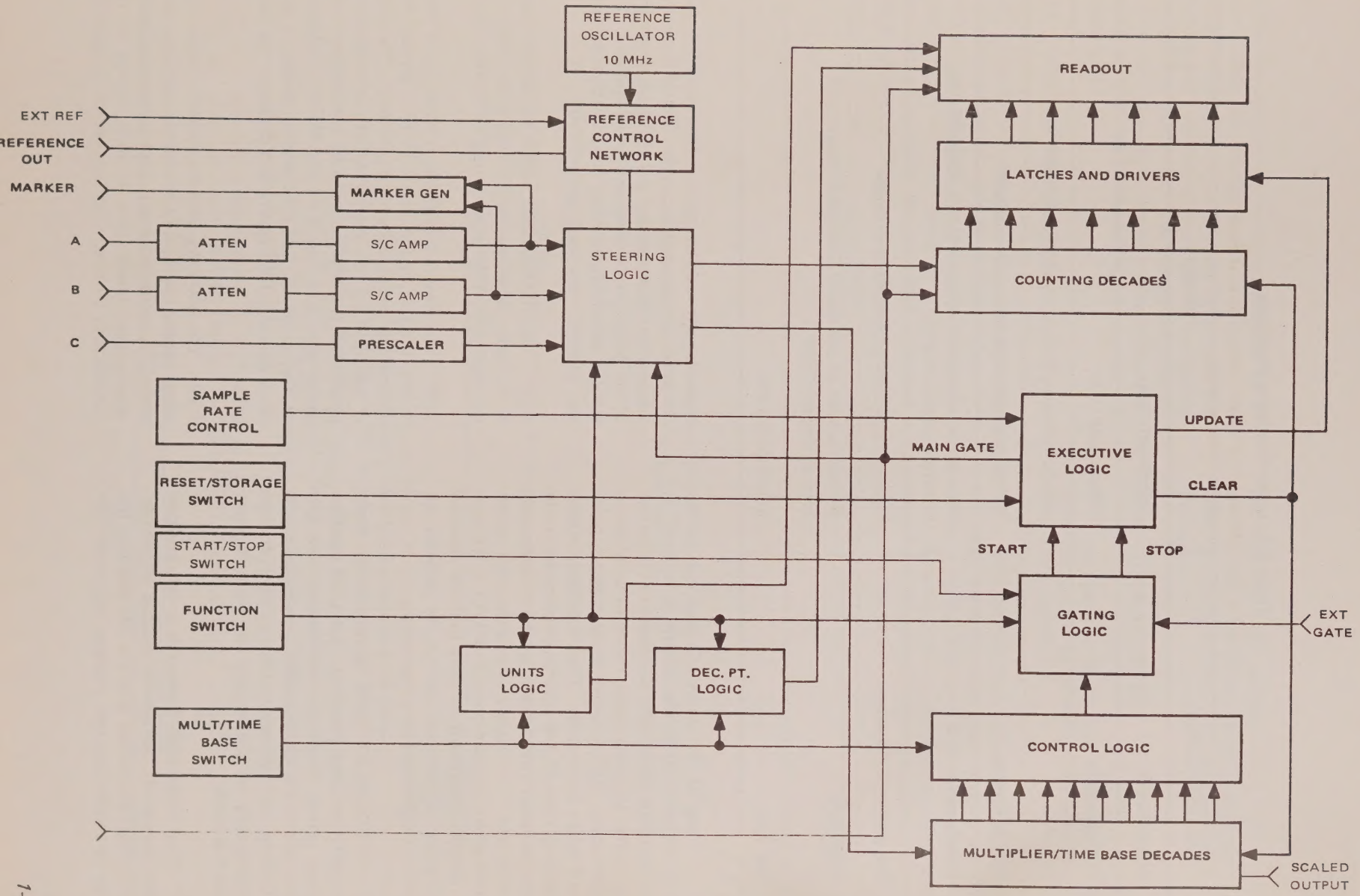


Figure 1.2 - Functional Block Diagram

Table 1.2 - Logic Functions Per Mode

Mode of Operation	Function
Frequency A	Selects gate time
Frequency C	Selects gate time
Period	Selects reference frequency to be counted
Period Average	Selects number of periods to be averaged
Time Interval	Selects the reference frequency to be counted during the time interval A to B
Time Interval Average	Selects number of periods to be averaged
Ratio A/B	Selects number of periods of Channel B input to be used as the gate time
Self Test	Selects gate time

1.15 Timing of the counter is governed by the Executive Logic. After the counter is "armed", it generates a Gate pulse upon command of the Gating Logic. After the Gate pulse, two additional pulses are generated: a Prop-Delay (proper delay) pulse and a Display Time pulse. The Prop-Delay allows for settling time of the accumulated count in the counter decades before Update and Print commands are generated. The Display Time pulse, with width determined by the front panel DISPLAY TIME control, controls the length of time that the accumulated count is displayed before the decades are cleared in preparation for a new count.

1.16 The DISPLAY TIME control on the front panel performs three functions. The CCW position removes power from the instrument, the CW position allows the meter to hold a measured count indefinitely, and mid-range of the control provides a continuously variable sample rate from 20 msec to over 5 seconds.

1.17 The STORAGE Switch is a two-position switch (storage-off, storage-on) located on the rear panel. When the switch is in the ON position, the display is continuous and changes only when the measurement is different from that counted during the previous measurement cycle. The OFF position disables the display storage so that the accumulation of the count can be observed by the operator. The RESET switch on the front panel enables the operator to start a new measurement cycle.

1.18 The START/STOP switch on the front panel manually generates the Start/Stop commands to the main gate. This switch is used in Totalize mode.

1.19 The Readout assembly is made up of eight in-line display devices with decimal inputs, five annunciator lamps and a main gate lamp. The count is displayed by the display devices with correctly positioned decimal points and annunciator indicators (nsec, μsec, sec, KHz, and MHz). In addition to the numerical and annunciator display, a gate lamp indicates the opening and closing of the main gate.

1.20 The counting decades consist of one high-speed decade made up of emitter-coupled-logic and seven TTL decade counters. Each decade applies the accumulated count data in BCD format to the Latches and Drivers. The latches are D-type flip-

flops which store a count for an indefinite period of time. When the storage switch is activated, the display is continuous and changes only when the measurement is different from that counted during the previous gate time. The drivers are BCD-to-decimal decoders that provide a decoded decimal output to light the corresponding numeral on the readout tube.

1.21 MEASUREMENT MODES.

1.22 Figures 1.3 through 1.13 summarize the basic principles of each operating mode. Any point (positive or negative) on the input waveform can be selected (by front panel controls) to trigger the generation of pulses to the main gate. The time-base is a precise oscillator producing pulses exactly 100 nseconds (10^{-7} seconds) apart. The Counter and Display is the digital counting logic and nixie tubes on which the result of the measurement is displayed.

1.23 TOTALIZE MODE.

1.24 In Totalize mode, the main gate is controlled by the manual START/STOP switch on the panel of the instrument.

1.25 With the first Start/Stop command, the control logic opens the main gate allowing the input pulses to be totalized in the counting decade circuits. Simultaneously, a continuous update is supplied from the control logic to enable the D-type flip-flops which make up the latches. The counter

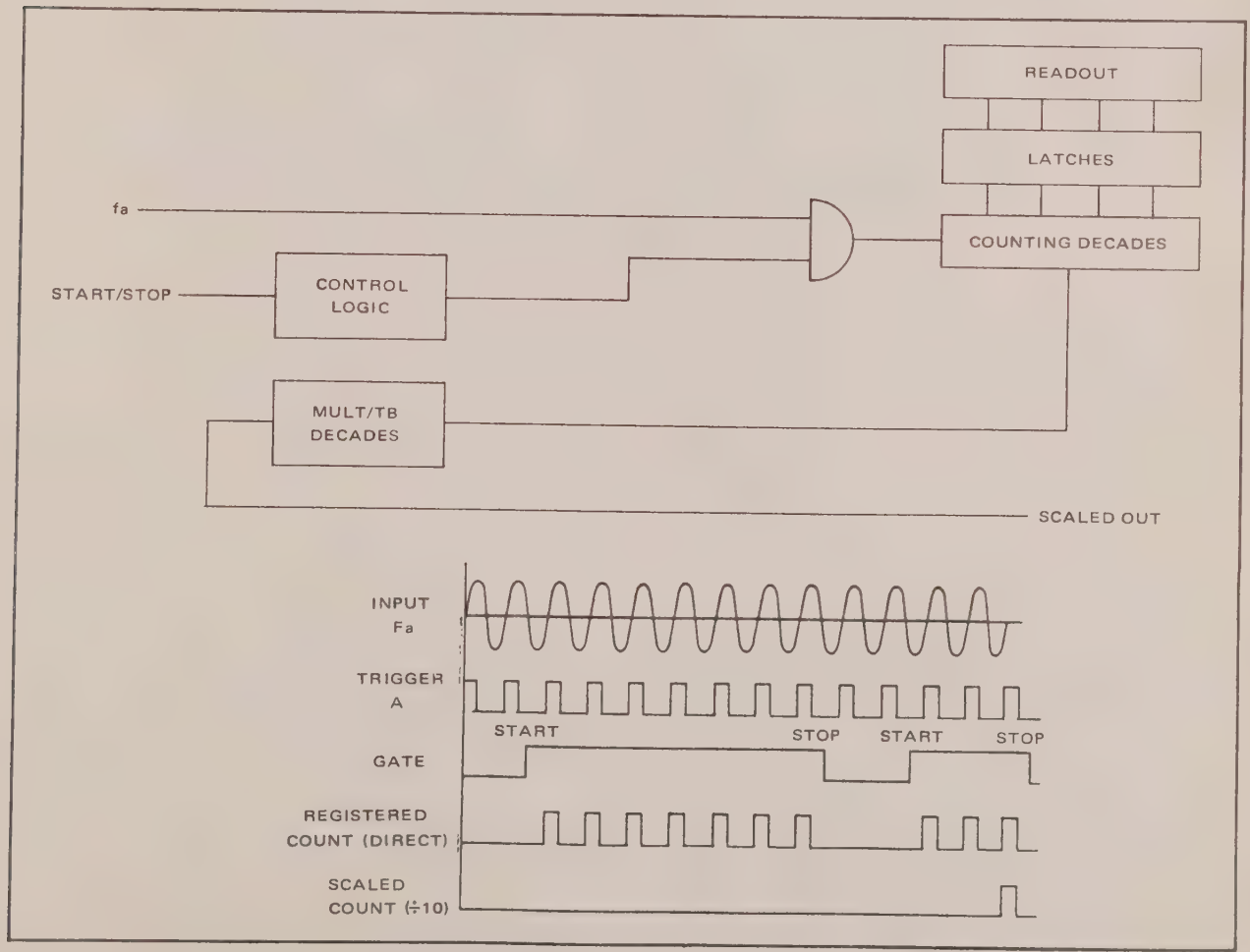


Figure 1.3 - Totalize Mode

readout display then represents the input pulses received during the interval between manual start and manual stop. External start/stop commands may be applied via a rear panel connector.

1.26 An additional facility incorporated in the counter during the totalizing mode is a scaled output connector on the rear panel of the instrument. Scaled Out is the input signal frequency scaled by 1/10N where N is the multiplier setting.

1.27 PERIOD MODE.

1.28 Period is the inverse of frequency. Therefore, period in the 8000B Series counter is measured with the input and internal reference oscillator connections reversed.

1.29 Timing signals derived by dividing down the 10 MHz clock signal (the specific decade division being determined by the setting of the Time Base Control) are presented to the input of the digital counter. Trigger pulses resulting from two consecutive signals at input A are applied to the control logic circuits. The first trigger pulse opens the main gate; the next closes it. During gate open time, the counter counts the applied timing signals. The count is then displayed on the readout directly in microseconds, milliseconds, or seconds according to the time base control setting.

NOTE

Low Frequencies may be determined more accurately by measuring period rather than frequency directly. This is because the larger period of a low frequency allows more counts to accumulate in a period measurement. Therefore, resolution and accuracy are both improved.

1.30 PERIOD AVERAGE MODE.

1.31 Period Average mode is used to obtain greater resolution and more accurate measurement.

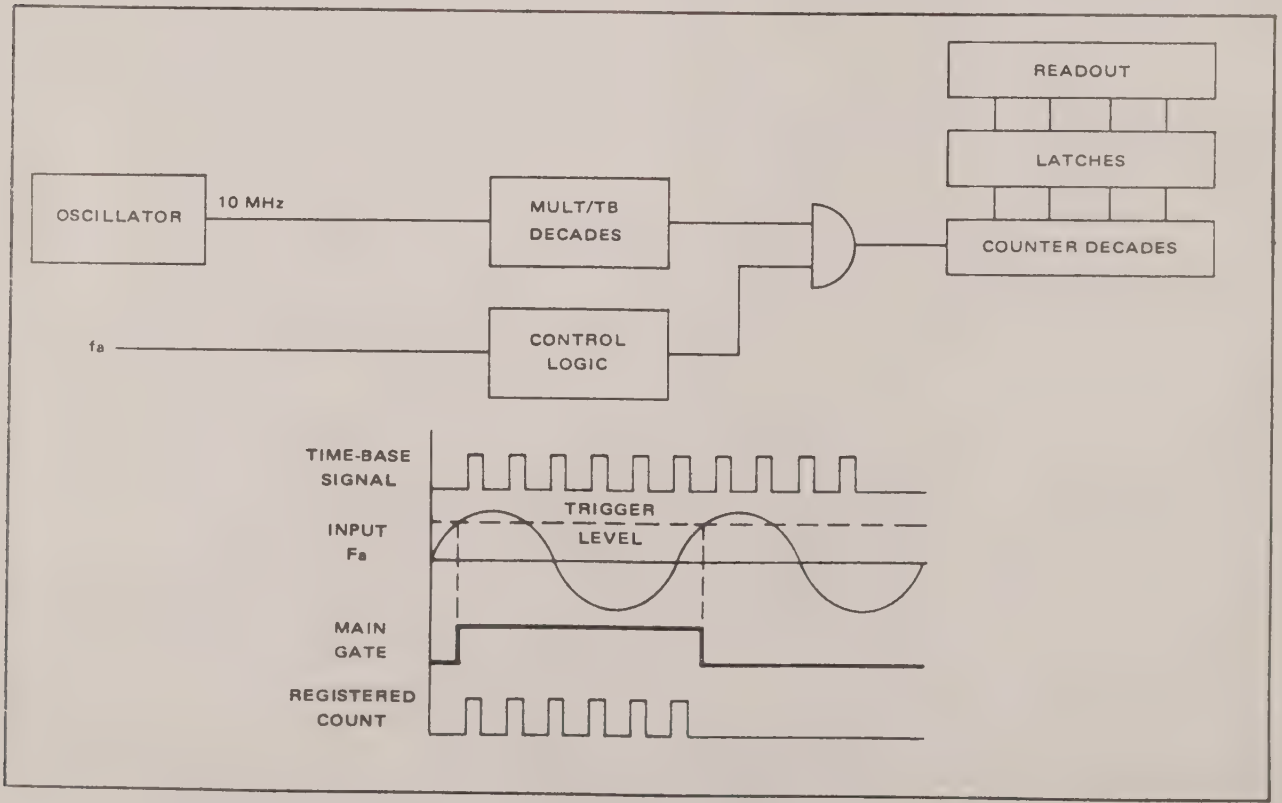


Figure 1.4 - Period Mode

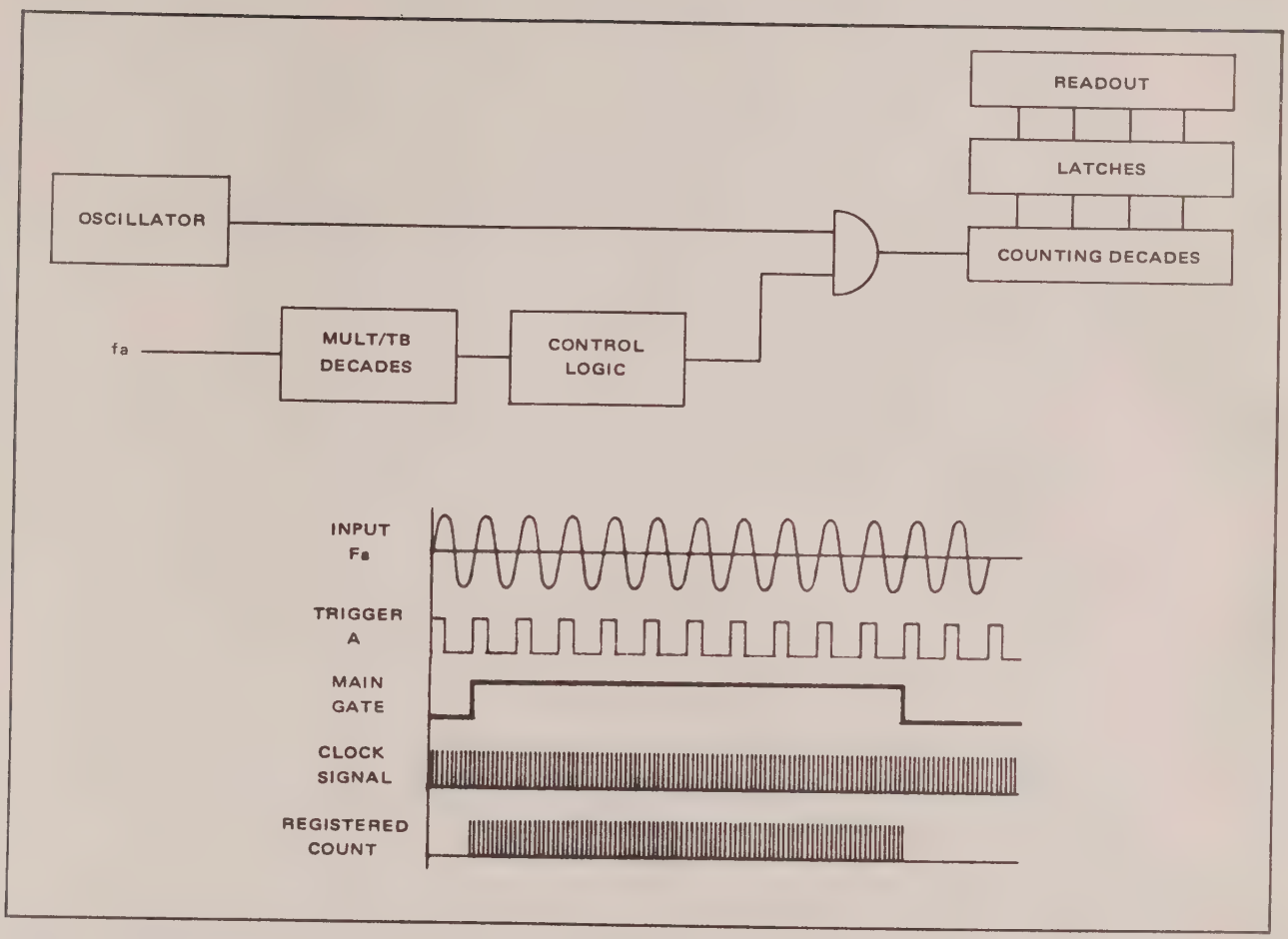


Figure 1.5 - Period Average Mode

The more periods over which a signal is averaged, the greater the accuracy of the measurement.

1.32 In this mode of operation, the reference oscillator is routed directly to the main gate and the unknown frequency is routed through the multiplier/time base decades to the control logic which, in turn, controls the main gate simultaneously with update pulses to the latches. The pulses occurring during main gate open are counted by the counting decades and an accurate readout measurement is displayed.

1.33 FREQUENCY MEASUREMENTS TO 150 MHz.

1.34 During direct frequency measurements, the counter compares an unknown frequency against a known frequency. The counter's logic is designed to present this information on an easy to read non-ambiguous display.

1.35 For a direct frequency measurement, input signal Fa is routed to the main gate of the counter. The internal reference oscillator supplies a 10 MHz signal through the multiplier/time base decades and through the control logic to control the main gate. Simultaneously, update pulses are routed from the control logic to the latches.

1.36 The number of pulses totalized during the main gate open interval is a measure of the average input frequency for that interval. The count obtained is displayed on the readout panel of the instrument. This display may be retained until such a time as a new sample is ready to be shown (measured).

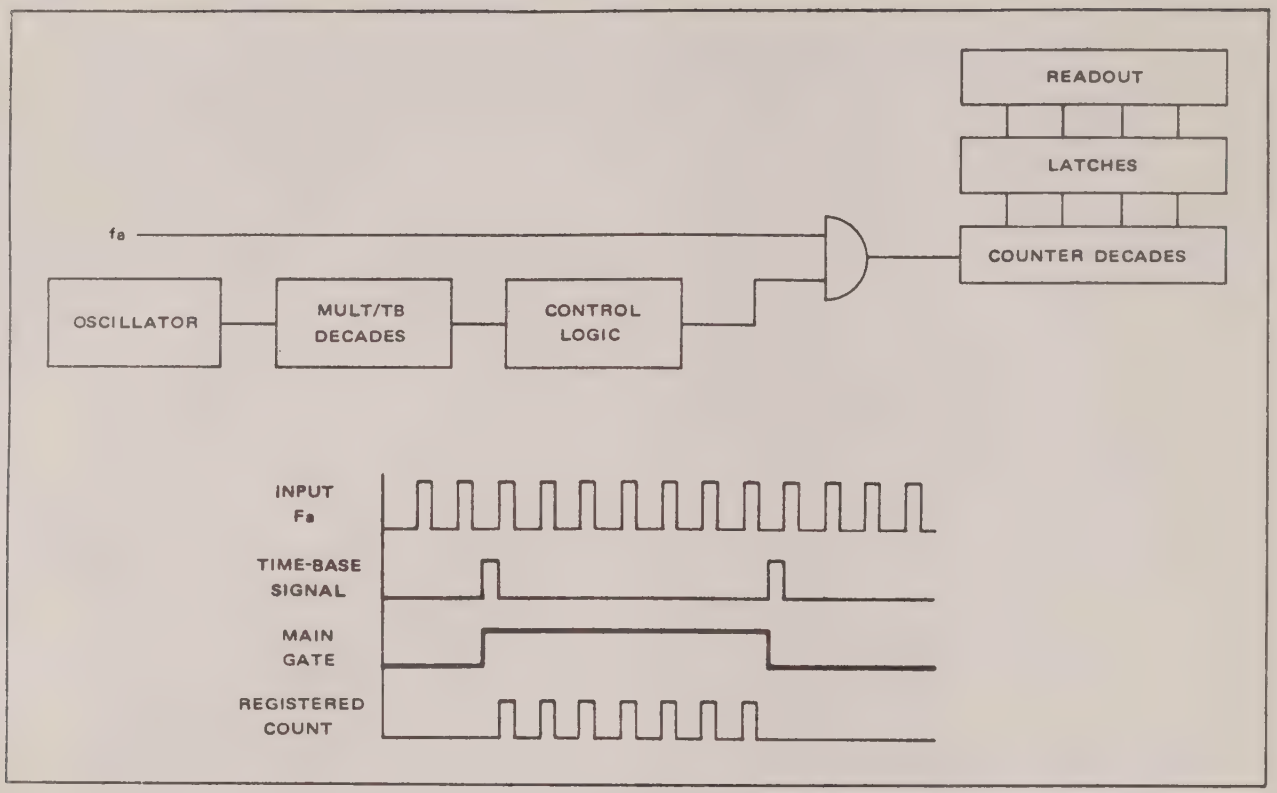


Figure 1.6 - Frequency Measurements to 150 MHz

1.37 FREQUENCY C MODE (TO 500 MHz).

1.38 During the Frequency C mode, the unknown RF is supplied to the main gate through an amplifier, automatic gain control circuit, and a divide-by-4 circuit.

1.39 The AGC circuit maintains the required amplifier gain which alleviates the need for manual trigger and range control. The divide-by-4 circuit is necessary to reduce the unknown frequency to a frequency which the main counter circuitry can resolve. A divide-by-4 circuit is also incorporated in the gate control line to enable direct readout.

1.40 A/B RATIO MODE.

1.41 This mode is identical in function to the frequency measurement mode, but substitutes an external signal for the internal reference.

1.42 The higher of the two frequencies which is to be measured is connected to input A; the lower to input B. Two successive trigger pulses derived from the signal applied to input B open and close the main gate. During the gate open interval, the counter counts the trigger pulses derived from input A and the ratio $Fa/_{Fb}$ is then displayed in the readout.

1.43 TIME INTERVAL MODE.

1.44 The time interval mode of operation allows measurement of the time interval between two electrical events. The inputs to channels A and B determine the start and stop of the interval. Slope and trigger level controls on the front panel allow variable trigger levels on the + or − slope of the input waveforms. The main gate is controlled by Start and Stop commands supplied to the control logic from the input channels. Simultaneously, pulses are supplied from the 10 MHz reference oscillator to the main gate by the multiplier/time base decades.

1.45 The pulses occurring during the main gate are counted by the counting decades and an accurate measurement is displayed.

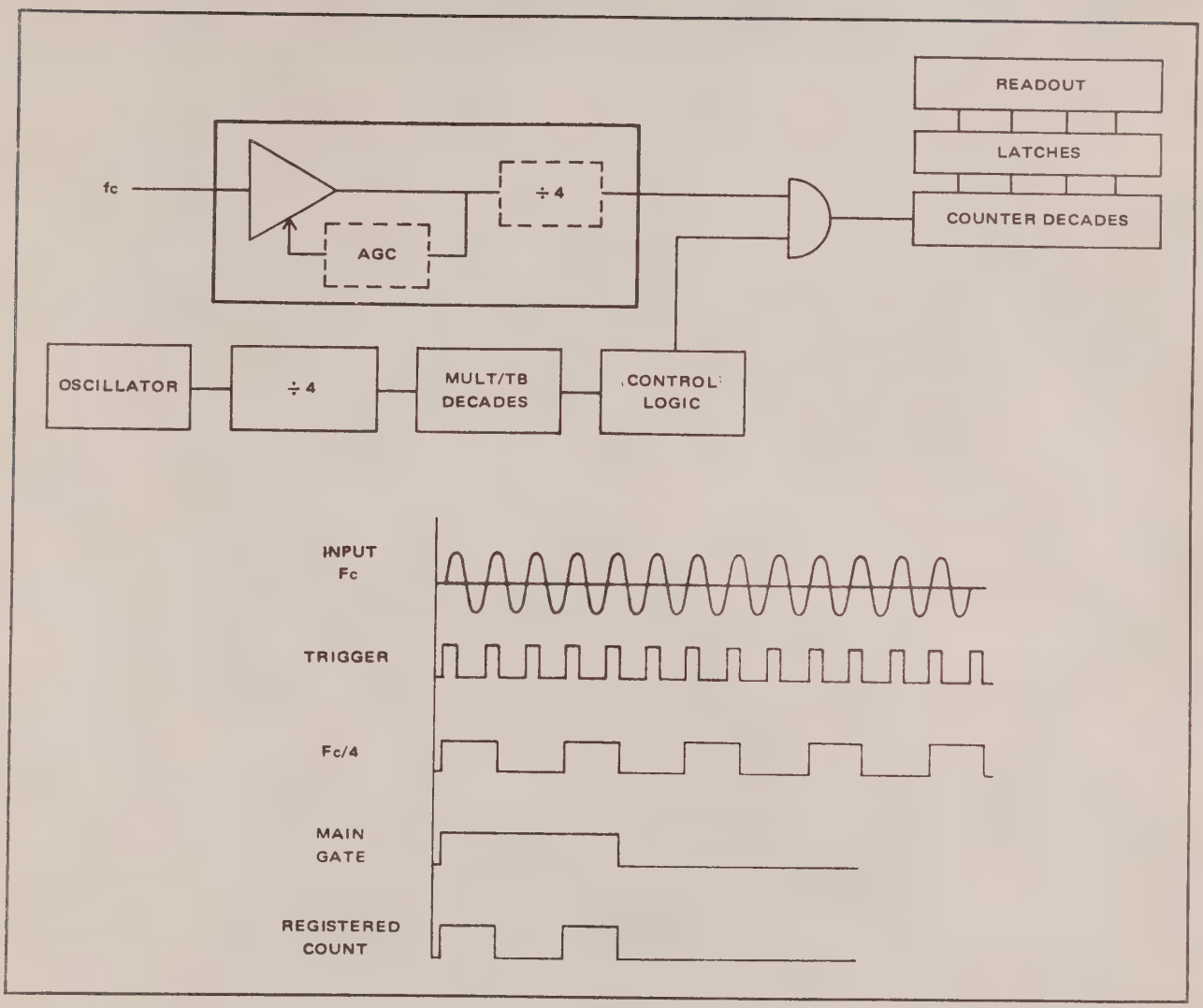


Figure 1.7 - Frequency C Mode

1.46 TIME INTERVAL AVERAGE.

1.47 Similar to the Time Interval mode of operation, the Time Interval Average mode measures the count accumulated during a multiple of intervals. It then averages the count by shifting the decimal point and displaying the result. This mode of operation makes it possible to achieve greater resolution and accuracy when measuring time intervals. The incoming signal, in this mode, must be repetitive and asynchronous with the counter's time base.

1.48 SELF-CHECK MODE.

1.49 The Self-Check mode of operation enables the operator to check for proper operation of the counter. The internal reference frequency of the frequency meter is used for two purposes. It is counted by the counting decades during the measurement time and it generates the time base frequency that produces the gating signal.

1.50 SPECIFICATIONS.

1.51 Specifications are tabulated in table 1.3.

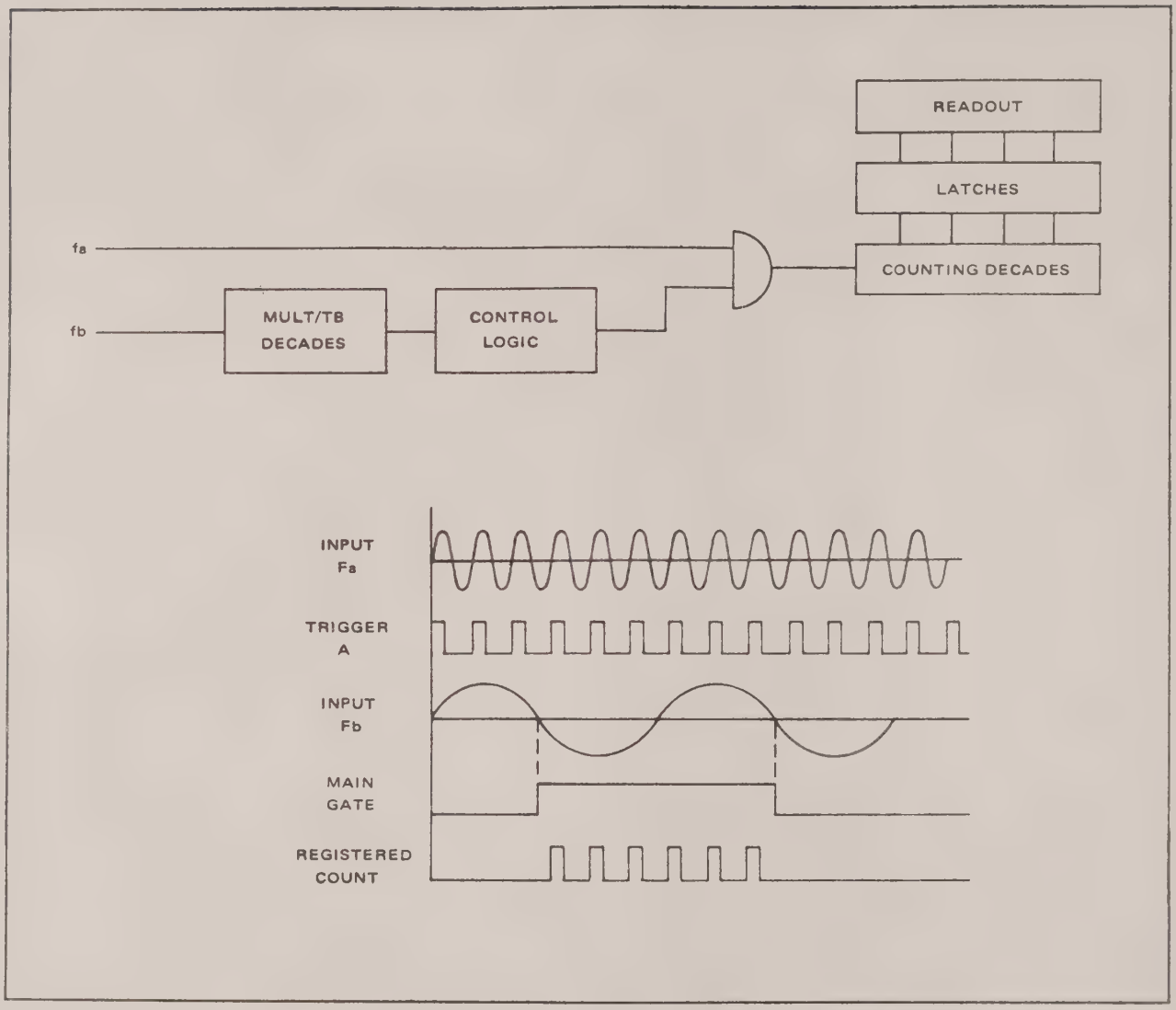


Figure 1.8 - A/B Ratio Mode

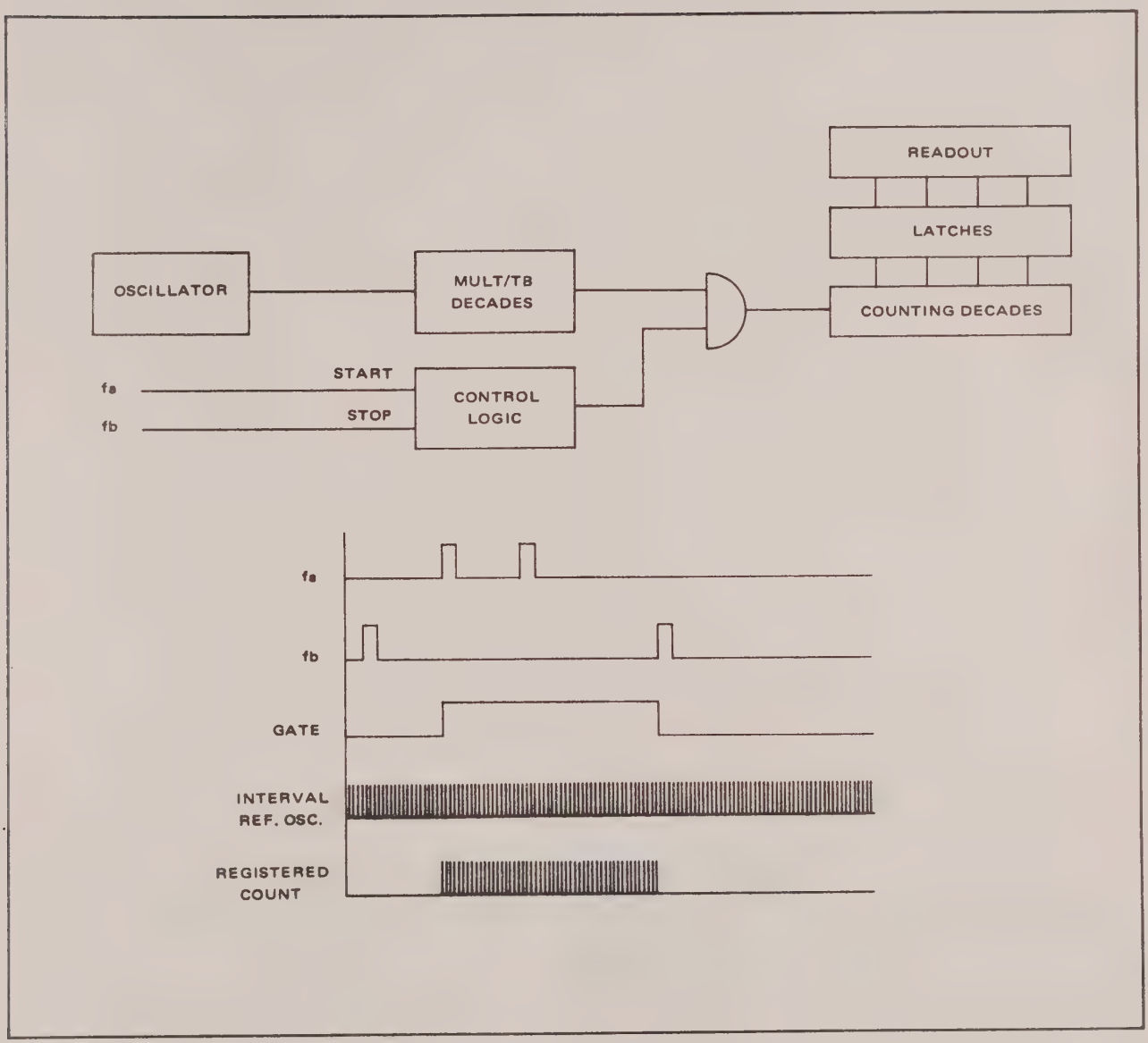


Figure 1.9 - Time Interval Mode (100 nsec)

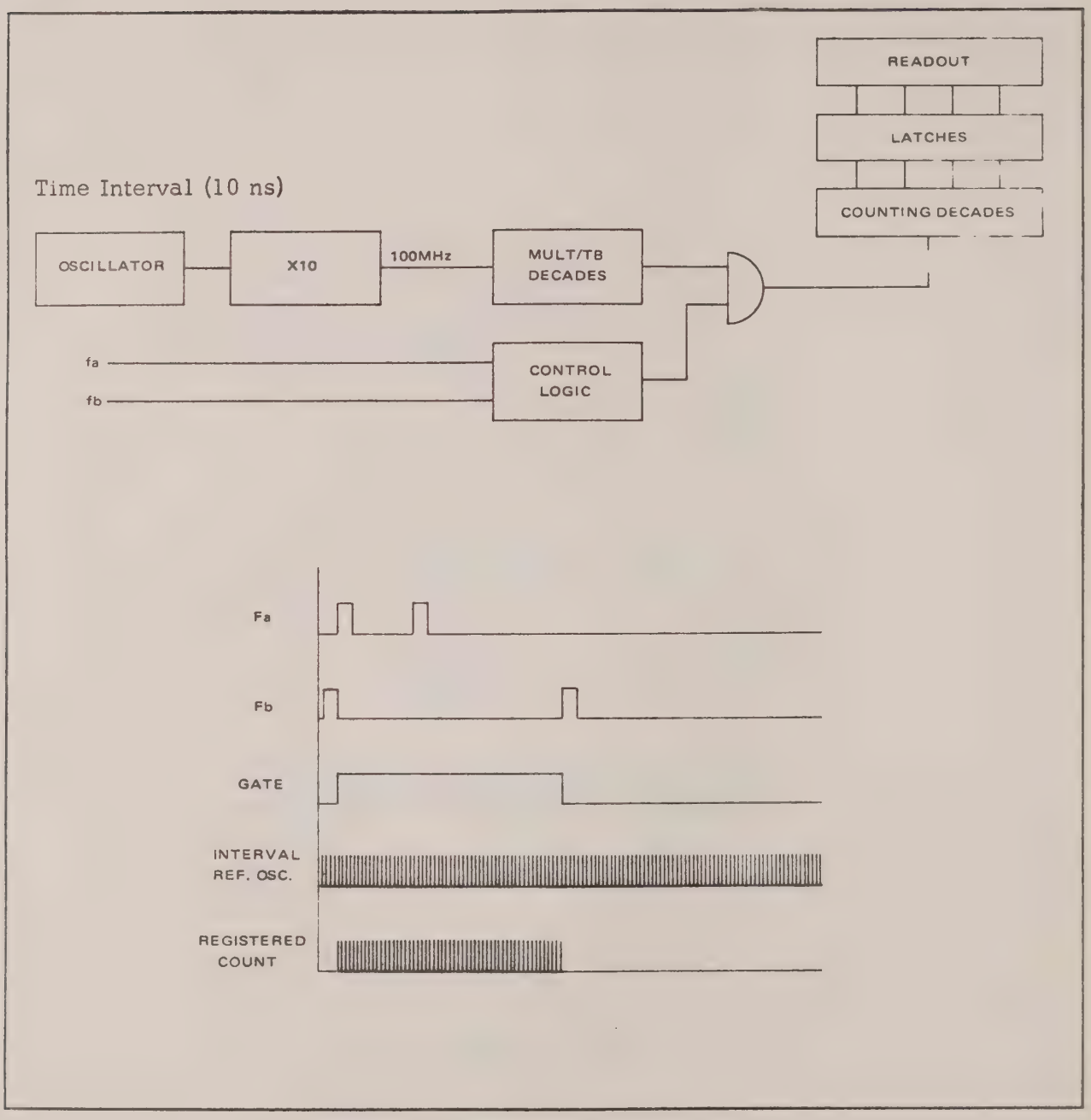


Figure 1.10 - Time Interval Mode (10 nsec)

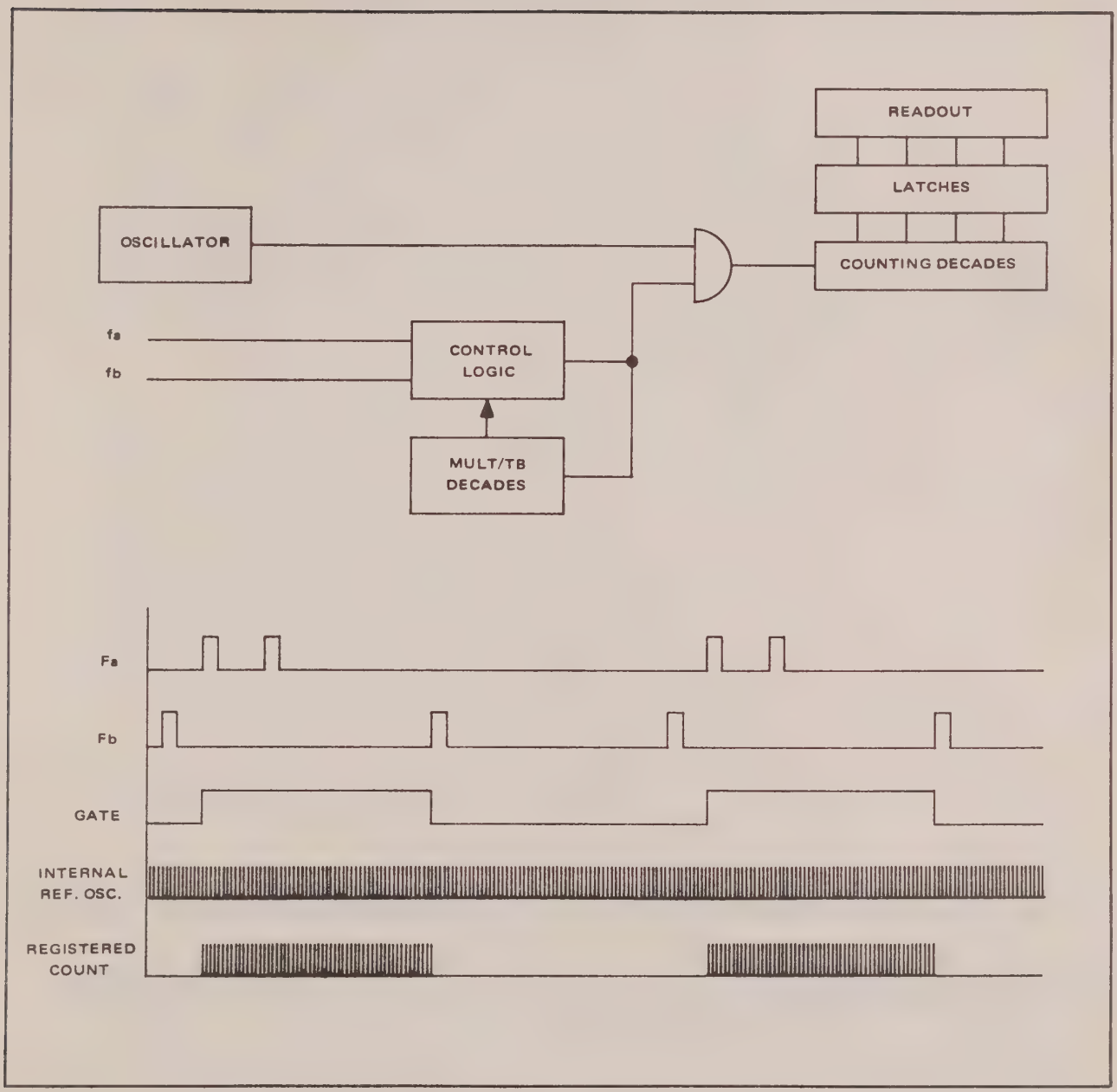


Figure 1.11 - Time Interval Average Mode (100 nsec)

NOTE: In T.I. Average mode, the input signal must be repetitive and asynchronous with the counter's time base.

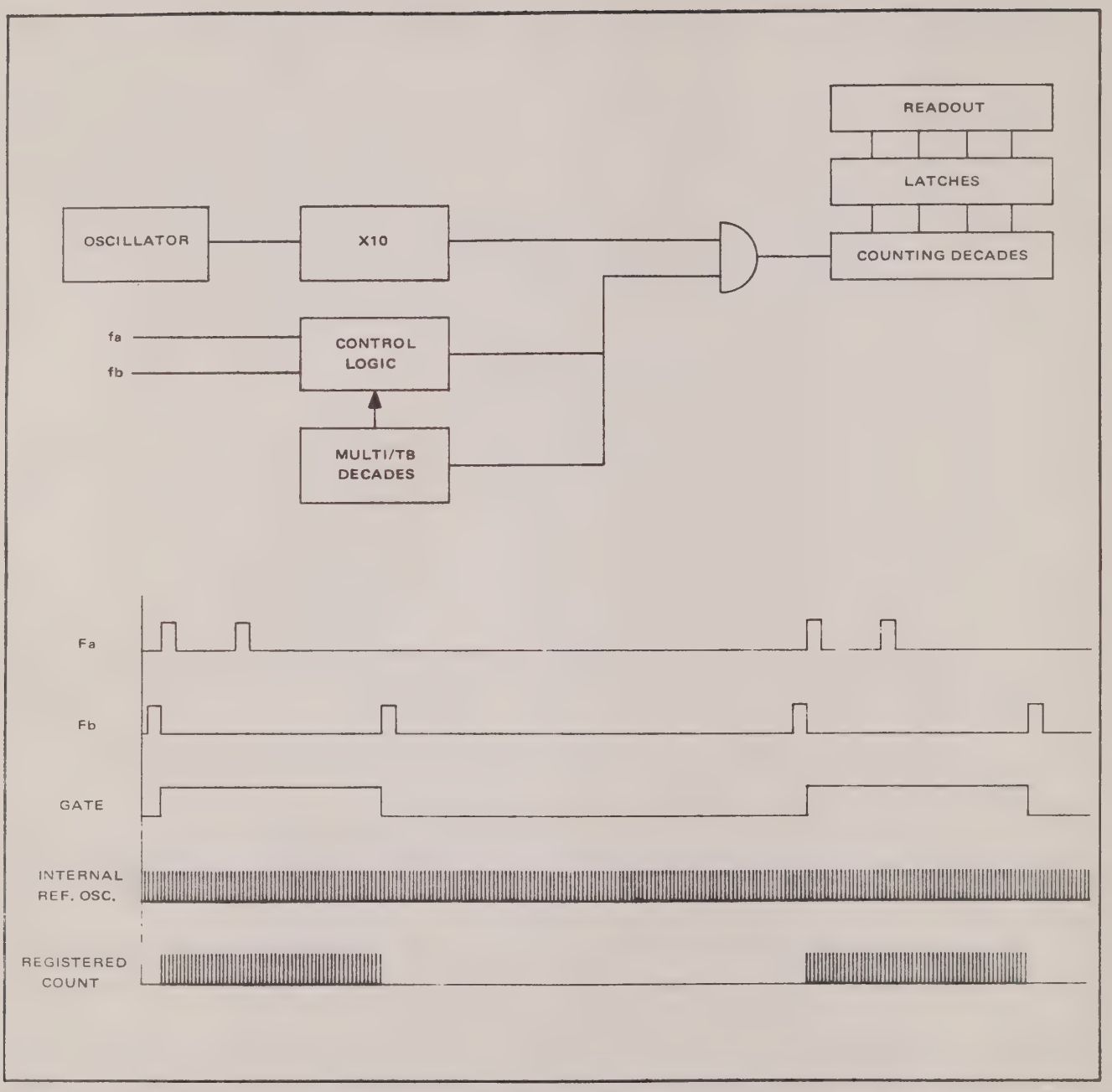


Figure 1.12 - Time Interval Average Mode (10 nsec)

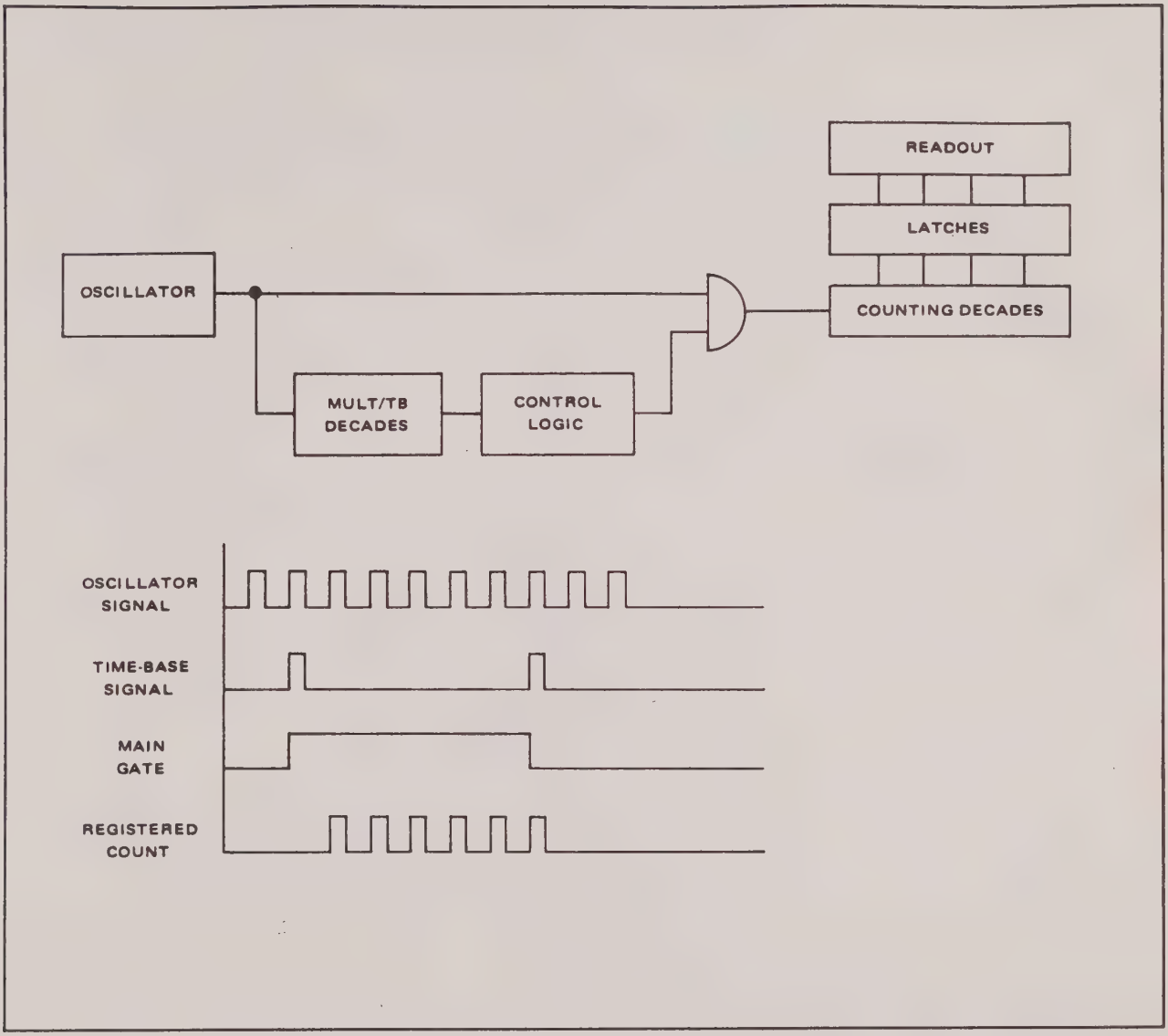


Figure 1.13 - Self-Check Mode

Table 1.3 - Model 8000B Specifications

FREQUENCY MEASUREMENTS to 150 MHz (All Models)

Frequency Range:	
dc coupled	0 to 150 MHz
ac coupled	10 Hz to 150 MHz
Accuracy:	± 1 count ± reference error
Input:	Channel A
Input Characteristics:	
Sensitivity, sinewave	50 mV rms to 100 MHz; 100 mV rms to 150 MHz
Sensitivity, pulse	150 mV peak; 4 nsec minimum width
Impedance	1 megohm shunted by 25 pF
Maximum input (without damage)	250V rms or 300V peak on all ranges except 150V rms or 200V peak to 1 MHz on 1V range
Voltage ranges	1, 10, 100 selectable
Trigger level	Continuously adjustable to ± 300% of input voltage range
Trigger slope	+ or −, selectable
Preset condition	0 trigger level
Measurement Time:	1 μsec to 100 seconds, selectable in decade steps
Display:	8 digits (optional 9 digits), KHz or MHz
Self Check:	10 MHz

FREQUENCY MEASUREMENTS to 550 MHz (Models 8020B, 8030B, 8035B)

Frequency Range:	
ac coupled	1 MHz to 550 MHz (10 MHz to 500 MHz with option 030)
Accuracy:	± 1 count ± reference error
Input:	Channel C
Input Characteristics:	
Sensitivity, sinewave	50 mV rms (1 mV with optional 030 pre-scaler)
Impedance	50 ohms nominal
Maximum Input (operating)	1V rms
Maximum Input (without damage)	5V rms
Automatic Gain Control	26 dB without adjustment (60 dB with option 030)

Table 1.3 - Model 8000B Specifications (Continued)

TIME INTERVAL MEASUREMENTS (Models 8010B, 8015B, 8030B, 8035B)

Range: (8015B, 8035B) (8010B, 8030B)	 10 nsec to 10^8 sec (10^9 sec with option 004) 100 nsec to 10^9 sec (10^{10} sec with option 004)
Resolution: (8015B, 8035B) (8010B, 8030B)	 10 nsec 100 nsec
Accuracy: (8015B, 8035B) (8010B, 8030B)	 ± 1 count ± reference error ± trigger error* ± 1 count ± reference error ± trigger error*
Input: separate mode common mode	 Channel A start and Channel B stop Channel A start and stop
Input Characteristics:	Channel A and B same as described in Frequency Ratio Mode
Display:	μsec, msec, sec

TIME INTERVAL AVERAGE (Models 8010B, 8030B)

Range:	150 psec to 10 sec (100 sec with option 004)
Accuracy:	± reference error ± 2 nsec + $\frac{\text{(trigger error* ± 100 nsec)}}{\text{No. of Intervals Averaged}}$
Input:	same as time interval
Intervals Averaged:	1 to 10^8, selectable in decade steps
Display:	nsec, μsec

*Trigger errors $\frac{0.0025\ \mu\text{sec}}{\text{Signal Slope}\left(\frac{\text{V}}{\mu\text{sec}}\right)}$

Table 1.3 - Model 8000B Specifications (Continued)

PERIOD MEASUREMENTS (All Models)

Range:	100 nsec to 10^9 sec (10^{10} sec with option 004)
Resolution:	100 nsec
Accuracy:	± 1 count ± reference error ± trigger error**
Input:	Channel A
Display:	μsec, msec, and sec

PERIOD AVERAGE (All Models)

Range:	100 nsec to 10 sec (100 sec with option 004)
Accuracy:	$\pm$ 1 count $\pm$ reference error $\pm \frac{\text{trigger error**}}{\text{No. of periods averaged}}$
Input:	Channel A
Periods Averaged:	1 to 10^8 selectable in decade steps
Display:	nsec, μsec, msec

FREQUENCY RATIO MEASUREMENTS (Models 8010B, 8015B, 8030B, 8035B)

Frequency Range: Input F_A Input F_B	 0 to 150 MHz 0 to 10 MHz
Ratio Range:	10^{-8} to 10^8 (10^9 sec with option 004)
Multiplier:	F_B scaled by 1 to 10^9 selectable in decade steps
Accuracy:	$\pm$ 1 count of $F_A \pm \frac{\text{trigger error of } F_B}{\text{multiplier}}$
Display:	Dimensionless

**Trigger error $\leq \frac{0.3}{(s/n)\ Fa}$ Where s/n equals signal to noise ratio and Fa equals frequency.

Table 1.3 - Model 8000B Specifications (Continued)

TOTALIZE MEASUREMENTS (All Models)

Frequency Range:	0 to 150 MHz
Count Range:	0 to 10^8 (10^9 sec with option 004)
Accuracy:	± 1 count

SCALING (All Models)

Frequency Range:	0 to 150 MHz
Scaling Range:	10 to 10^{10} selectable in decade steps

GENERAL SPECIFICATIONS (All Models)

Internal Reference Oscillator Characteristics:	
Aging Rate	± 1 x 10^{-8} per day, averaged for 30 days
Temperature Stability	± 2.5 x 10^{-6}, 0°C to + 50°C
Voltage Stability	± 1 x 10^{-7}, with 10% line voltage variation
Time Base	.01 Hz to 10 MHz selectable in decade steps
Output	10 MHz square wave, buffered, TTL compatible
External Reference: (8015B, 8035B) 5 or 10 MHz (8010B, 8020B, 8030B) 1, 5, or 10 MHz	1V rms into 1 kilohm
Display:	Long-life digital display tubes; 8 standard, 9 optional (option 004)
Input/Output Connectors:	BNC
Operating Temperature:	0° to 50°C
Line Voltage:	50 Hz to 400 Hz; 115V ± 10%

Table 1.3 - Model 8000B Specifications (Continued)

GENERAL SPECIFICATIONS (All Models) continued

Power Requirement:	40 watts maximum
Weight:	Net, 15 pounds; shipping, 20 pounds
Dimensions (HxWxD):	3-15/32 x 16-3/4 x 14 inches

SYSTEMS INTERFACE (Optional on All Models)

Programming Inputs:	
Single Line Commands	Function, time base, external gate, +/– slope, hold, reset
Logic Levels	Low TTL level or contact closure to ground for single line commands, inputs are TTL gates
Analog	Supply ± 10V into 10 kilohm to set desired level; accuracy is ± 5% of input range
Electrical Outputs:	
Binary Coded Data	1-2-4-8 code, each data digit
Single Line Signals	Print, units, decimal point
Logic Levels	Positive true, from standard TTL integrated circuits
Marker Output:	Negative-going pulse, 15 volt amplitude, rear BNC, duration equal to channel A trigger point to channel B trigger point

SPECIAL NOTE

The shipping carton and its internal support structure have been scientifically designed for maximum protection of the instrument. Dana recommends saving the carton and contents for use in future reshipping of the instrument. Alternate packing methods, such as plastic foam blocks and loose packing material, may prove to be insufficient for maximum protection and result in damage during shipment.

If reshipping is required and the original carton is not available, special packing instructions can be obtained from Dana Labs' Product Service Department.

SECTION 2

INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 The counter is bagged in a polyethylene dust cover. Four Ethafoam corner posts are pressed onto the corners. This assembly is fitted into a larger heavy duty fiberboard container which is securely taped. This form of packaging provides the instrument with a high degree of protection from normal shipping hazards. Before unpacking, examine the container for any signs of external damage. Remove the counter from the container and carefully check for any signs of damage; i.e., broken switches or knobs, scratches or dents. If damage to either the shipping container or the counter is found, notify the carrier and Dana immediately.

2.1.2 The counter, as shipped, is designed for bench top operation. A standup bracket is provided under the case to aid in reading the visual display and operating the instrument. To adapt the counter for rack mounting, optional flanges (option 003) may be added at any time. The flanges are fitted into the grooves provided on the sides of the counter and the two locking devices on each flange are turned ¼ turn to secure the flanges.

2.2 POWER CONNECTION

An eight-foot, three-wire, power cable is supplied with the instrument. This cord connects to a three-pin power connector at the rear of the unit. Unless otherwise specified, the instrument is set up for 115 Volt, 60 cycle operation.

2.3 FUSE

The power fuse holder is located on the rear panel of the instrument and uses a 1 amp 3AG fuse.

SECTION 3

OPERATION

3.1 CONTROLS.

3.2 The function of each of the operating controls is explained in the following paragraphs.

3.3 FUNCTION Switch. This nine-position switch selects the measurement mode of the instrument.

a. REMOTE. In this position, the Multiplier/Time Base switches are inhibited. Selection of the Multiplier/Time Base (M/TB) and of the measurement mode is made through the REMOTE connector on the rear panel of the instrument.

b. CHECK. This position selects the self-check mode in which the 10 MHz internal oscillator is connected to the counter and time base decades and the frequency is displayed on the readout (see figure 1.13).

c. PERIOD. In Period mode, the Channel A input is connected to the gating logic to establish the gate time and the 10 MHz reference is connected to the counter through the Multiplier/Time Base (M/TB) decades (see figure 1.4).

d. PER. AVG. (Period Average). In Period Average measurement mode, the Channel A input is applied to the gating logic through the M/TB decades and the 10 MHz reference frequency is connected to the counter (see figure 1.5).

e. FREQ A and FREQ C. In these two measurement modes, the Channel A input or the prescaled Channel C signal is applied to the counter and the 10 MHz reference is connected to the Time Base decades to generate the desired gate time (see figures 1.6 and 1.7).

f. TOTALIZE. In Totalize mode, the Channel A input is applied to the counter. The START/STOP switch on the front panel or the External Gate signal (rear panel connector) establishes the gate time (see figure 1.3).

g. T.I. (Time Interval). In this mode, the 10 MHz or 100 MHz reference is applied to the counter through the M/TB decades. The Channel A input starts and terminates the gate when the SEP/COM switch is set to Common. When the SEP/COM switch is on Separate, Channel A starts the gate and Channel B terminates it (see figure 1.9).

h. A/B. In this ratio measurement mode, the Channel A input is connected to the counter. The Channel B input is connected to the multiplier decades to generate proper gate time (see figure 1.8).

i. T.I. AVG. (Time Interval Average). This mode is similar in operation to the Time Interval mode except that the reference frequency is applied directly to the counter and the M/TB decades establish the number of intervals to be averaged (see figure 1.11).*

3.4 MULTIPLIER/TIME BASE Switches. This bank of ten pushbutton switches selects either the multiplier factor or a time base depending on the measurement mode selected:

a. In Check mode, the switches select gate time.

*The input signal must be repetitive and asynchronous with the counter's time base.

b. In Period mode, they select the reference frequency to be counted.

c. In Period Average mode, they select the number of periods to be averaged.

d. In Frequency A and Frequency C modes, they select gate time.

e. In Totalize mode, they select the scaling factor of the scaled output.

f. In Time Interval, the switches select the reference frequency to be counted during time interval A to B.

g. In ratio (A/B), they select the number of periods of Channel B frequency to be used as gate time.

h. In Time Interval Average mode, the switches select the number of intervals to be averaged.

3.5 DISPLAY TIME/POWER/HOLD Switch. This switch, when fully counter-clockwise, removes power from the instrument. The full clockwise position is HOLD in which the measurement is retained and displayed indefinitely (until RESET). The mid-position provides a continuously variable interval between measurements (20 milliseconds to 5 seconds).

3.6 START/STOP Switch. This switch starts and terminates the gate when operating in the Totalize measurement mode.

3.7 RESET. This switch resets the digital display to zero and arms the counter for a new reading. If the instrument is in Hold, RESET must be depressed to obtain a new measurement.

3.8 INPUT VOLTAGE; +/– Switch. This control and switch combine to select any point on the input as the trigger levels of Channel A and B. The +/– switch selects either the positive or negative slope while the Input Voltage control selects the magnitude. The input voltage switch selects a range of 1, 10, or 100 volts. The outer vernier control varies each range by ± 300%.

3.9 SEP/COM Switch. See paragraph 3.3g.

3.10 STORAGE Switch. This is a rear-panel switch. When ON, the display is continuous and changes only when the measurement is different from the previous measurement cycle. The OFF position disables the display storage so that the accumulation of the count can be observed by the operator. The RESET switch enables the operator to start a new measurement cycle.

SECTION 4

THEORY OF OPERATION

4.1 GENERAL.

4.2 This section covers the operation of the Series 8000B Counter. The instrument, divided into its six major functional blocks, is shown in figure 4.1. The routing of signals through the blocks is dependent on the measurement selected. Where circuitry differences occur between the different models, the paragraph heading indicates the model covered.

4.3 Drawings in this section are included for the purpose of the description. Full schematics and assembly drawings are included in Section 7.

4.4 FUNCTIONAL BLOCK DESCRIPTION.

4.5 SIGNAL INPUT CIRCUITRY. This includes attenuating and conditioning circuitry (single channel for the Model 8020B, dual channel for the 8010B, 8015B, 8030B, and 8035B) and Prescaling circuitry (Models 8020B, 8030B, and 8035B). The attenuators and signal conditioners operate in precisely the same manner; for purposes of this discussion, the Channel A circuitry is described.

4.6 Channel A (721149). The signal applied to the input connector (J201) with the coupling switch set to AC, flows through capacitor C1A; with DC selected, the

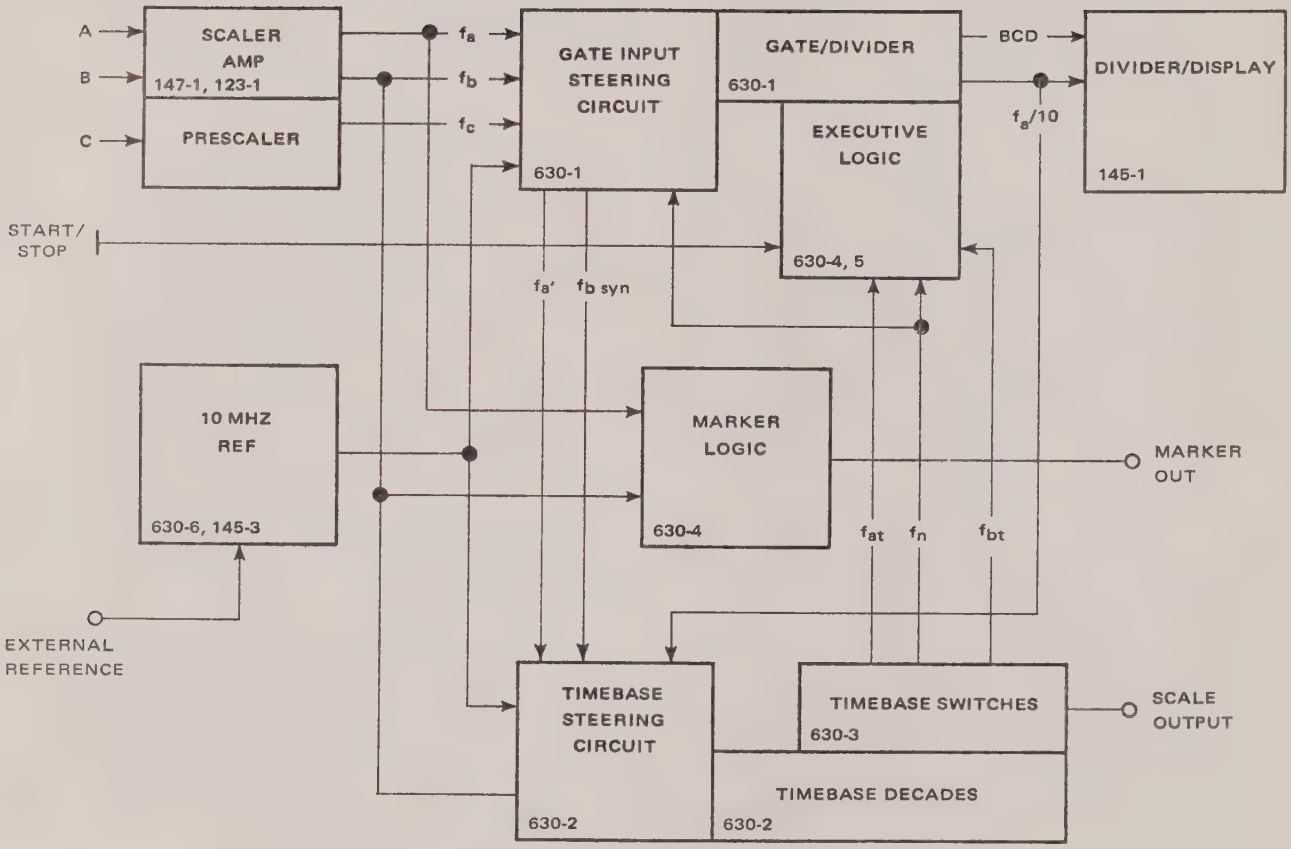


Figure 4.1 - Functional Diagram 8000B

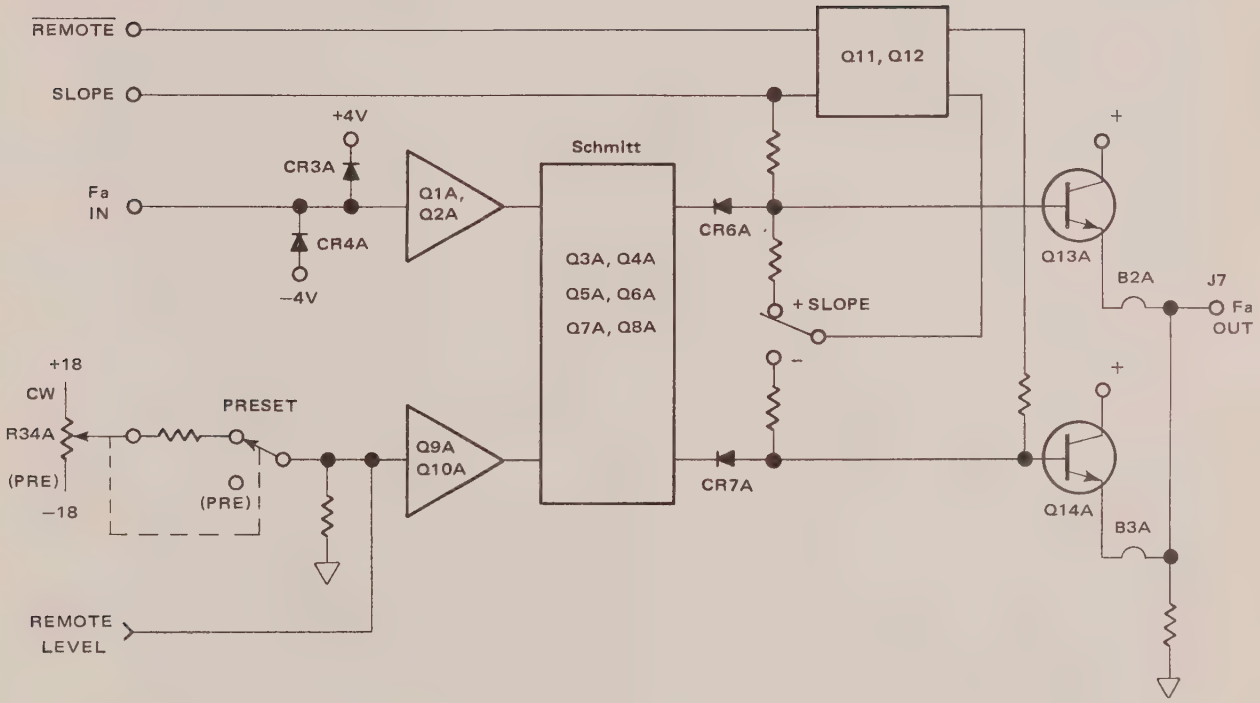


Figure 4.2 - Signal Conditioning Block Diagram 8000B

capacitor is bypassed through the coupling switch (S207). The signal flows through the attenuator according to the range selected; in the one volt range, the signal passes directly through the range switch, in the 10 volt range, the signal is attenuated by a factor of 10, and in the 100 volt range the signal is attenuated by a factor of 100. From the switch the signal passes through a 100 Kohm resistor in parallel with a 47 pfd capacitor to the signal conditioning network.

4.7 SIGNAL CONDITIONING. As shown in figure 4.2, the signal from the Channel A attenuator (fa in) flows through follower circuits Q1A and Q2A to the input side of a Schmitt trigger consisting of transistors Q3A, Q4A, Q5A, Q6A, Q7A, and Q8A. The signal from the attenuator is prevented from exceeding $\pm$ 4 volts by the clamp diodes CR3A and CR4A. The trigger level of the trigger circuit is determined by the potential applied to the input of the follower circuits consisting of Q9A and Q10A. With PRESET selected (the extreme counter-clockwise position of the front panel Level control) and assuming no remote level input,the trigger level is zero volts. With PRESET out, the level is adjustable by the level control, across $\pm$ 300% of the range selected.

4.8 The trigger circuit generates two outputs (180^{o} out of phase) which are gated through diode CR6A or diode CR7A, depending on the position of the slope switch. With + Slope selected, diode CR6A is held to ground and a positive pulse, generated during the positive going edge of the trigger input signal, passes through CR7A, through Q14A and bead B3A to connector J7. With - Slope selected, diode CR7A is held to ground and a positive pulse, generated during the negative going edge of the trigger input signal, passes through CR6, through Q13A and B2A to connector J7. In local control, transistor Q11A is conducting and the signal that

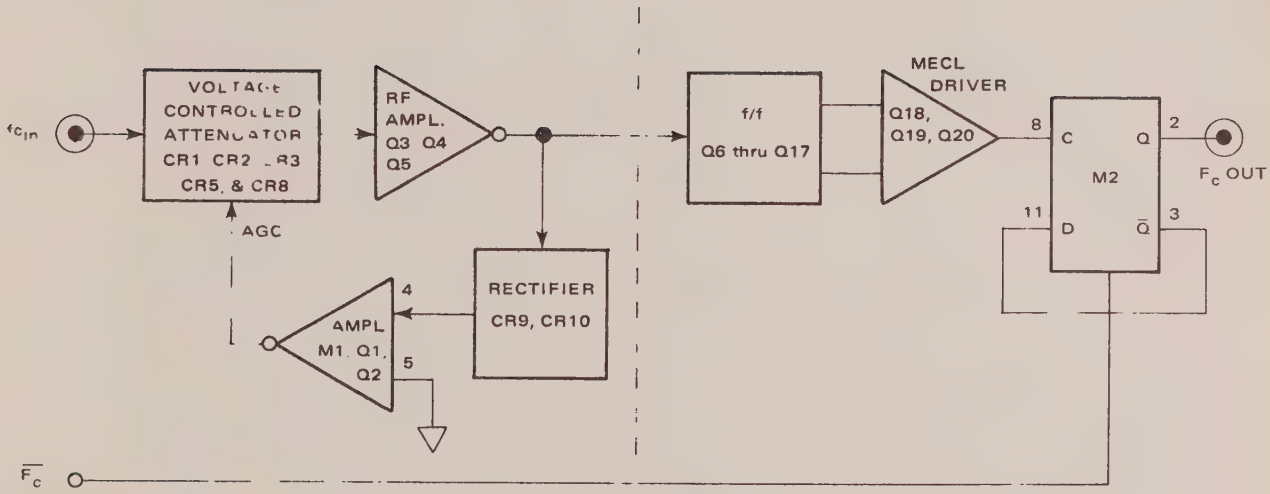


Figure 4.3 - 550 MHz Prescaler

appears at J7 is determined by the position of the +/- (SLOPE) switch on the front panel. In remote, Q11A is open and Q12A determines the signal at J7.

4.9 SEP/COM (8010B, 8015B, 8030B, 8035B). The separate-common switch when set in the SEP position routes the signal applied to the A connector to the A INPUT circuitry and routes the signal from the B connector to the B INPUT circuitry. With the switch in the COM position, the signal applied to the A connector is routed to both input circuits and the B connector is open.

4.10 500 MHz PRESCALER (8020B, 8030B, 8035B). The prescaler accepts frequencies as high as 550 MHz, automatically controls the amplitude of the signal and divides the frequency of the signal by a factor of 4 (the scaling reduces the incoming signal to a rate compatible with the High speed counter). The circuitry, shown simplified in figure 4.3, is divided into two sections; the automatic gain control section, and the frequency divider section.

4.11 AUTOMATIC GAIN CONTROL. The input signal from connector (on the front panel) passes through the voltage controlled attenuator to the RF amplifier. The attenuator consists of 2 diodes in series with the signal path and three diodes shunting the signal path. With no signal from the AGC amp the diodes in series are forward biased providing a low impedance signal path while the shunting diodes are back biased and provide little attenuation to the signal; as the AGC signal goes negative the series diodes conduct less, increasing their apparent impedance while the diode in shunt begin conducting and attenuate the signal. The signal from the

attenuator passes through the three stage amplifier (Q3, Q4, Q5) which increases the signal level to approximately 200 mV rms.

4.12 The output of the amplifier is fed to the divider section and to a voltage rectifier circuit consisting of diodes CR9 and CR10. The rectifier produces a positive dc voltage level proportional to the RF level of the amplifier output which is used, after amplification and inversion by differential amplifier M1, to control the attenuator. The gain control circuit holds the signal level of the amplifier input to approximately 50 mV.

4.13 FREQUENCY DIVIDER. This portion of the prescaler consists of a discrete, 12 transistor FLIP/FLOP, a driver circuit (Q18, Q19, Q20) and MECL D-type FLIP/FLOP M2. The output of the RF amplifier drives the discrete F/F, producing a divide-by-two output. The output is amplified by Q18 and Q19 and fed through emitter follower Q20 to flip/flop M2. The reset line of M2 is controlled by $\overline{Fc}$; when $\overline{Fc}$ is false (FREQ C is selected), M2 divides by two and the signal ($\div$ 4) is fed to the Input Gate Steering circuitry; when $\overline{Fc}$ is true (FREQ C is not selected) the flip/flop output is held true.

4.14 REFERENCE CONDITIONING CIRCUIT. The conditioning circuitry converts the reference signal to a 10 MHz square wave signal and routes it to the instrument Steering circuits. For instrument Models 8015B and 8035B, a 100 MHz signal is also generated. This circuit processes a reference signal supplied either from the instruments internal frequency source or from an external standard through rear panel

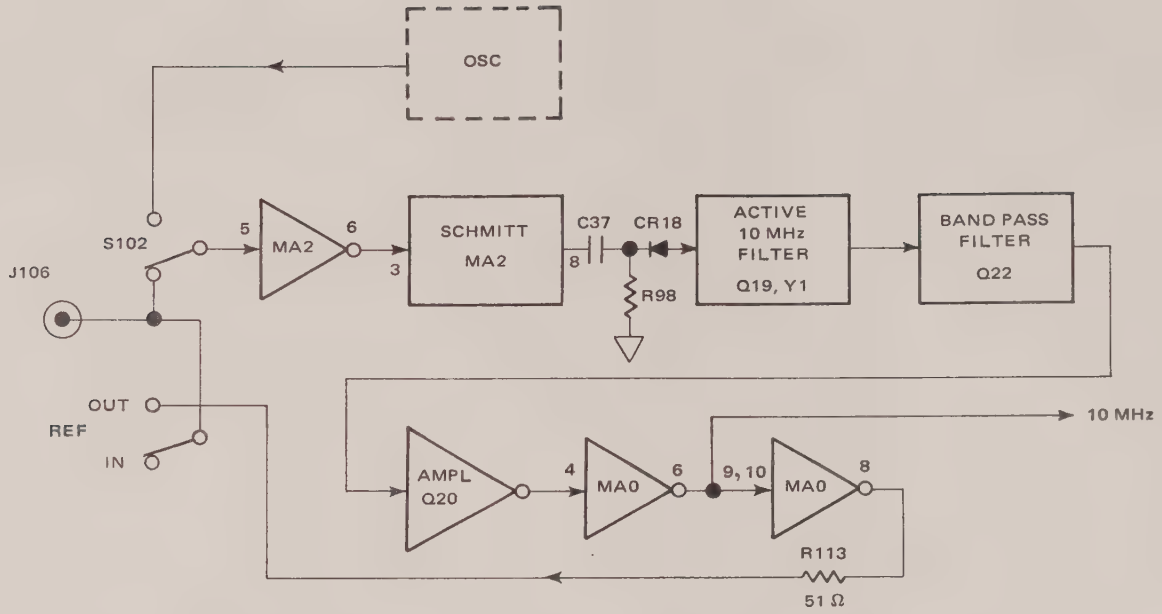


Figure 4.4 - Reference Conditioning Circuit (8010B, 8020B, 8030B)

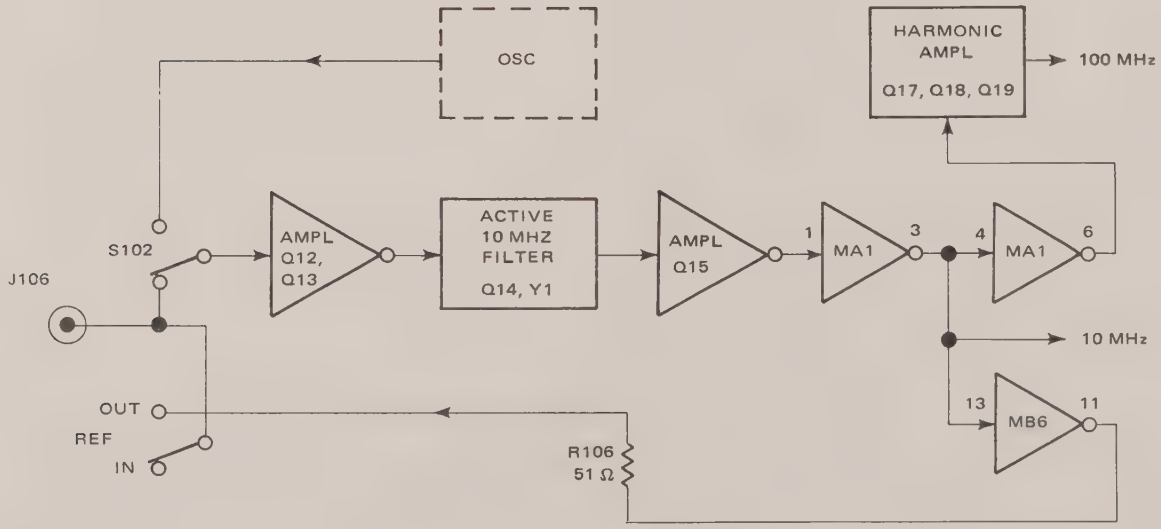


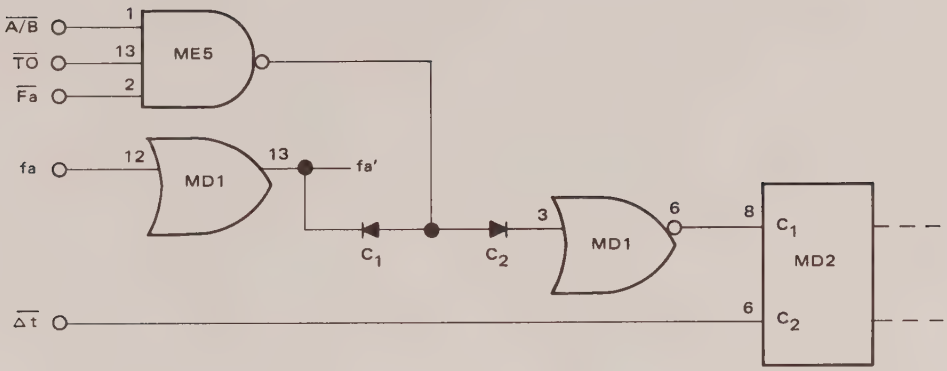
Figure 4.5 - Reference Conditioning Circuit (8015B, 8035B)

connector J106 , one of which is selected by the rear panel REF switch S102. The internal frequency source is a self contained, temperature compensated oscillator located on the Readout Board. The external reference (1, 5, or 10 MHz for Models 8010B, 8020B, and 8030B and 5 or 10 MHz for Models 8015B and 8035B) must be capable of delivering 1 volt RMS at the connector J106 (input impedance is 1K ohm). With the REF switch set to the IN position, an external signal is fed to the input of the conditioning circuitry and the internal frequency source is open; with the OUT position selected, the internal frequency source is supplied to the input of the conditioning circuitry and the output of the conditioning circuitry is routed to connector J106 for use as a secondary standard source.

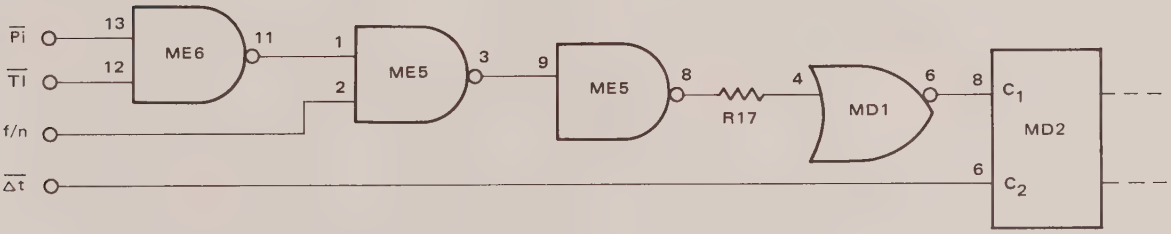
4.15 MODELS 8010B, 8020B, and 8030B. This circuit is shown in simplified form in figure 4.4. The signal from the REF switch is shaped (by the limiting action of inverter MA2) and fed to the Schmitt trigger circuit (MA2), producing a square wave. The trigger output is integrated through the capacitor resistor combination (C37, R98) and the negative spikes from the integrated signal are fed to the ringing filter circuitry (Q19, Y1). This circuit produces a 10 MHz dampened oscillation that is sustained by input spikes at 10 MHz and by sub harmonics at 1 and 5 MHz. The active filter output is fed to the bandpass filter, increasing the amplitude of the signal and removing the harmonics. The signal then flows through amplifier Q20 and two NAND gates (MA0) wired as inverters. The output of the first gate (MA0-6) is routed to the Steering circuits in the instrument, the output of the second gate (MA0-8) passes through 51 ohm resistor R113 and, in the OUT position of the reference switch, to connector J106.

4.16 MODELS 8015B and 8035B. This circuit is shown in simplified form in figure 4.5. The signal from the reference switch is routed to the amplifier consisting of Q12 and Q13. This circuit passes 10 MHz signals and doubles inputs of 5 MHz to 10 MHz. The output of this circuit drives the active 10 MHz filter which passes only 10 MHz. The active filter output is amplified by Q15 and routed through three NAND gates wired as inverters (MA1 and MB6). The output of one gate MA1-3 is routed to the Steering circuits of the instrument (10 MHz) and to the input of the other two inverters. The output at MB6-11 is fed through 51 ohms resistor R106 and, with the reference switch in the OUT position to connector J106. The output at MA1-6 is fed to the harmonic amplifier circuitry consisting of transistor Q17, Q18, and Q19. Transistor Q17 is a frequency multiplier, producing an output of 50 MHz from the harmonics of the 10 MHz input. Transistor Q18 functions as a doubles producing an output of 100 MHz. Transistor Q19 is a 100 MHz amplifier, the output of which is fed to the Timebase Steering circuitry.

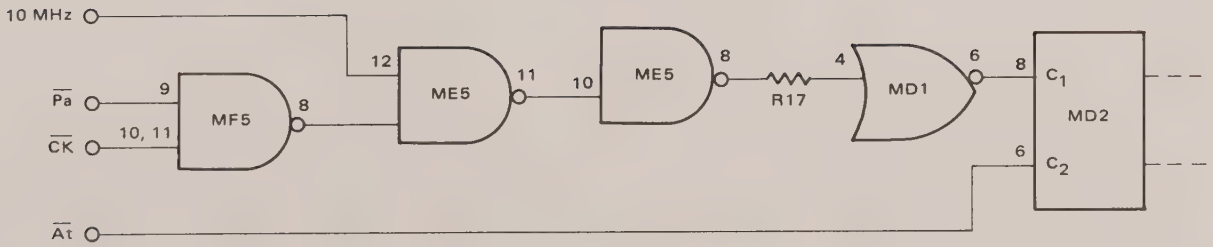
4.17 GATED COUNTER. The gated counter consists of four high-speed counters (MD2, MD3, and MD4) interconnected to form a divide by ten circuit. The binary outputs of the counter are buffered and inverted through transistors Q3, Q4, Q5, and Q6 and routed to latch ME9 on the counter board. The buffered 4 and 8 bits from the counter are combined in NAND gate MC5 to form a quasi-square output with a frequency equal to 1/10 of the input signal (f/10). The counter is controlled by a gate (C2) in the first flip/flop MD2. When C2 is false, the pulses at the input (C1) are counted; when C2 is true, they are not. The gate control line is designated $\overline{\Delta t}$.



(a) Ratio, Totalize or Freq A selected

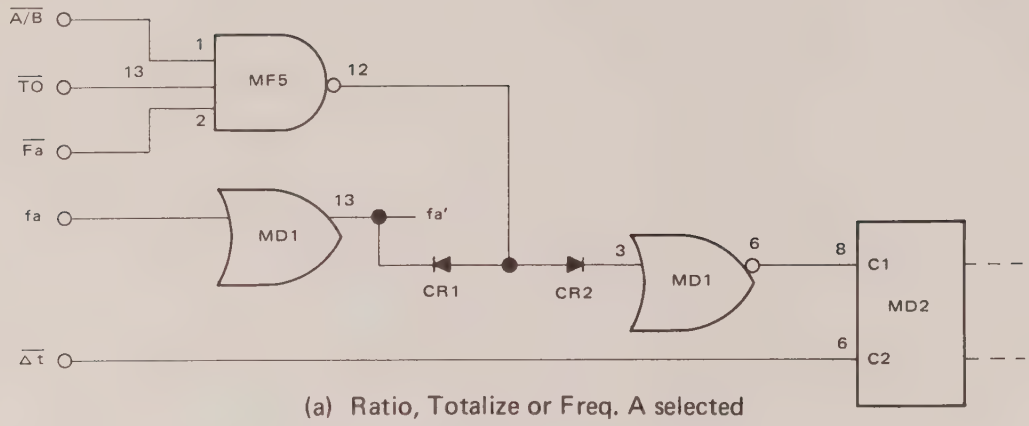


(b) Period or Time Interval selected

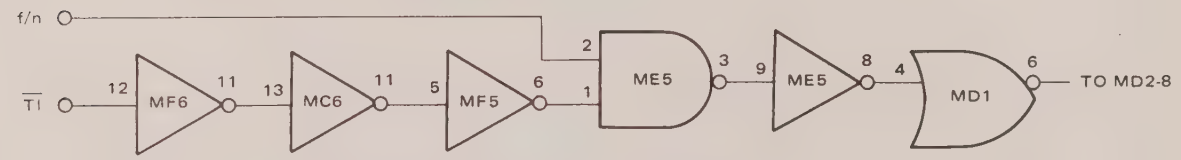


(c) Period Average or Check selected

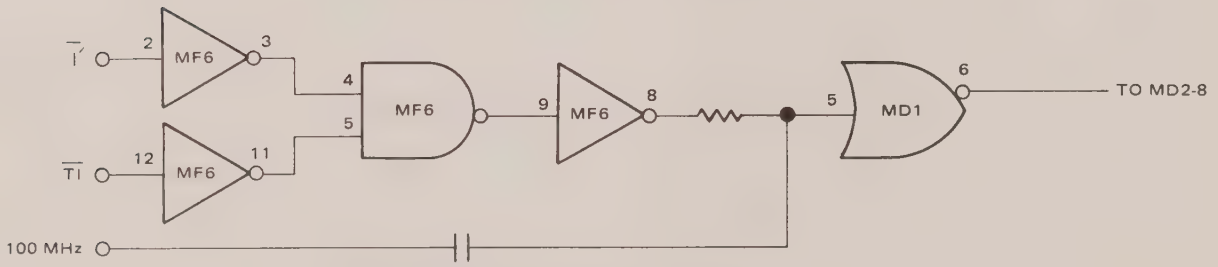
Figure 4.6 - Gated Counter Steering 8010B, 8020B, 8030B



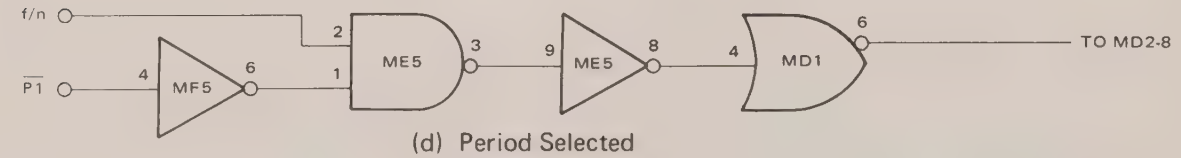
(a) Ratio, Totalize or Freq. A selected



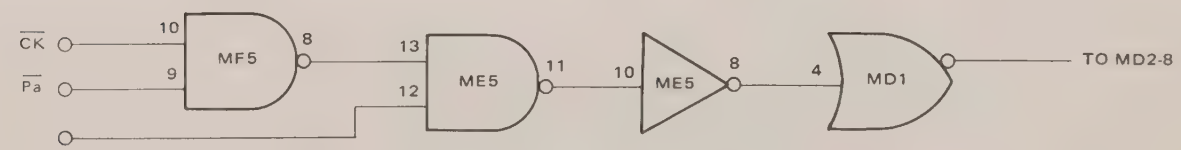
(b) Time Interval (all Ranges except #1)



(c) Time Interval (#1 range)

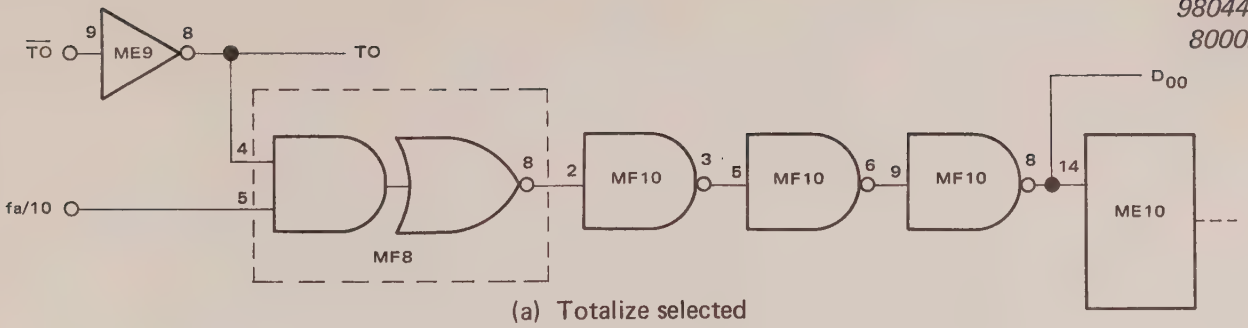


(d) Period Selected

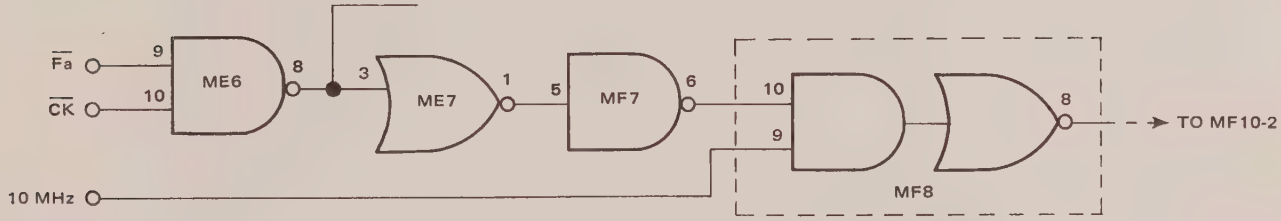


(e) Period Average or Check Selected

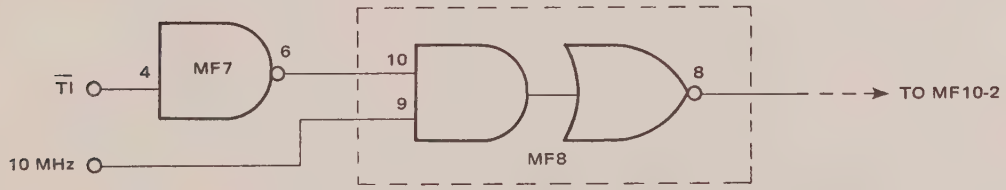
Figure 4.7 - Gated Counter Steering (8015B, 8035B)



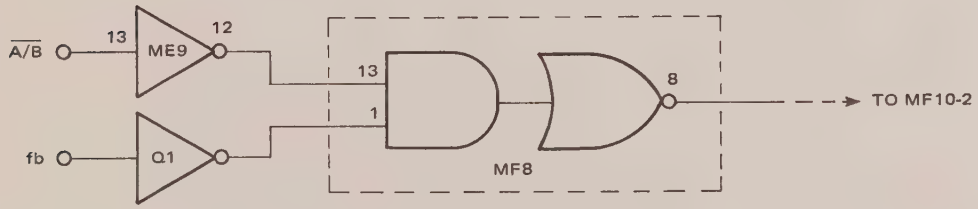
(a) Totalize selected



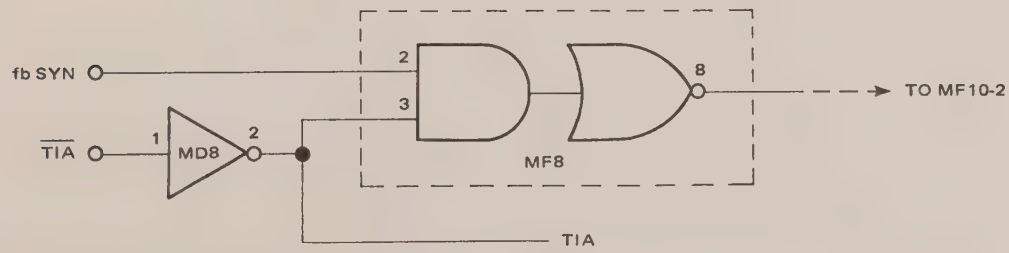
(b) Frequency A or Check selected



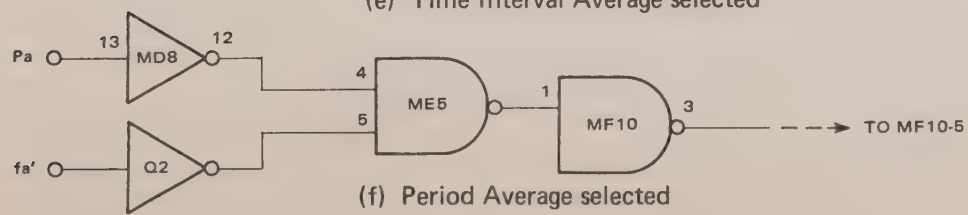
(c) Time Interval selected



(d) Ratio selected



(e) Time Interval Average selected



(f) Period Average selected

Figure 4.8 - Time Base Input Steering

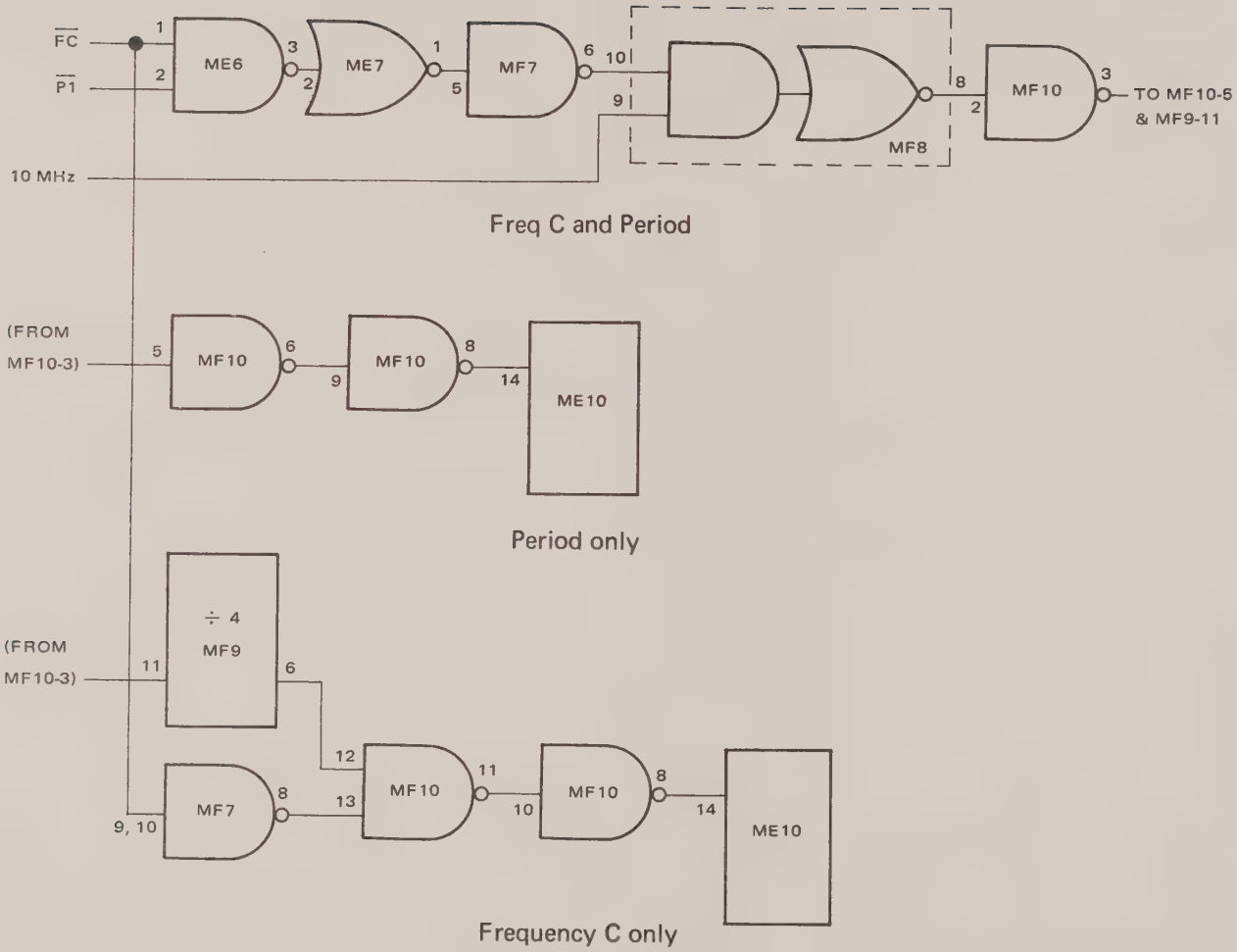


Figure 4.9 - Timebase Input Steering Period & Frequency C

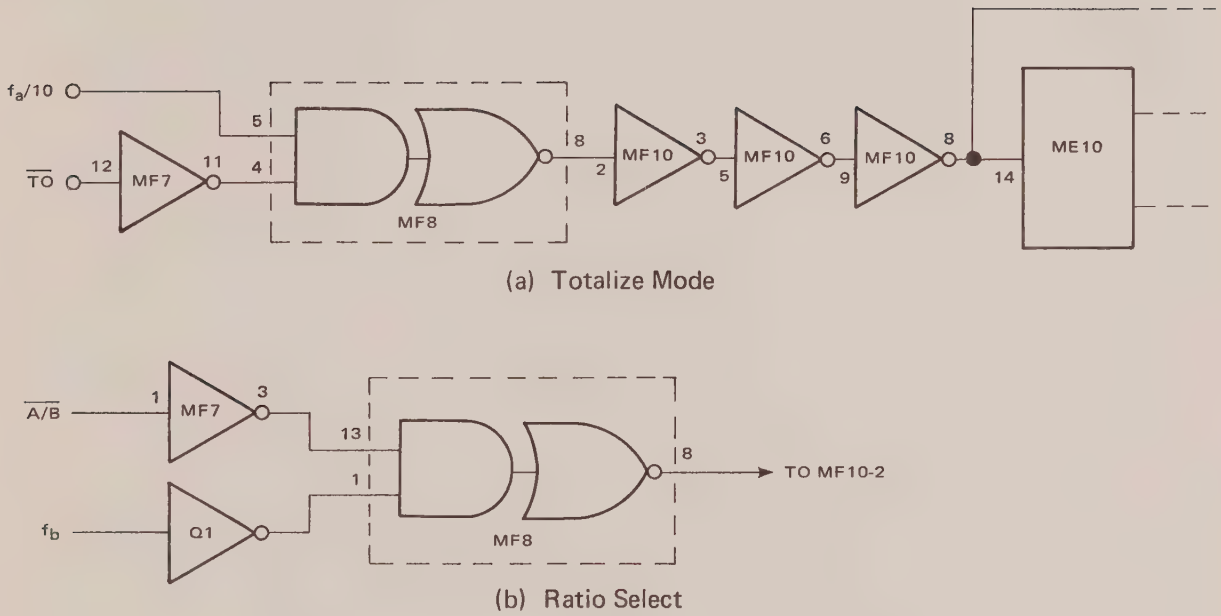


Figure 4.10 - Timebase Steering (Circuit Variations for 8015B, 8035B)

4.18 COUNTER/DISPLAY. This circuitry counts, stores and displays the number of pulses received from the gated counter circuit, and consists of seven decade counters, eight latches, eight gas numeric display tubes and eight tube drivers (an additional tube, driver, latch, and decade are included in instruments having the 9th digit option 004). Transistor Q1 controls the read-hold lines of all the latches. A true UPDATE signal from the executive logic allows each latch to assume the same levels as the decade counters to which it is connected; a false UPDATE allows the latches to store the information. The T^2 line, when true, resets all the decade counters to zero.

4.19 TIME BASE DECADES. This circuit consists of nine decade counters (MA9, MA10, MB10, MB9, MC9, MC10, MD9, MD10, ME10) connected in series. The input to the counter is from the timebase steering circuitry. The input signal (D_{00}) and the output of each decade are fed to the Timebase switching circuit. The decades are reset by the low state of $\overline{T^2 \text{ CLEAR}}$.

4.20 TIMEBASE Switches. These switches select any one of ten outputs of the timebase decades. Each decade output line is fed through a separate gate which is enabled by a control signal generated by the switch.

4.21 GATED COUNTER STEERING CIRCUIT. This circuitry routes signals to the gated counter input according to the measurement mode selected. Signal flow through the circuit is shown in figures 4.6 and 4.7.

4.22 TIMEBASE STEERING CIRCUIT. This circuitry routes signals to the timebase divider circuit according to the measurement mode selected. Signal flow through the circuit is shown in figures 4.8, 4.9, and 4.10.

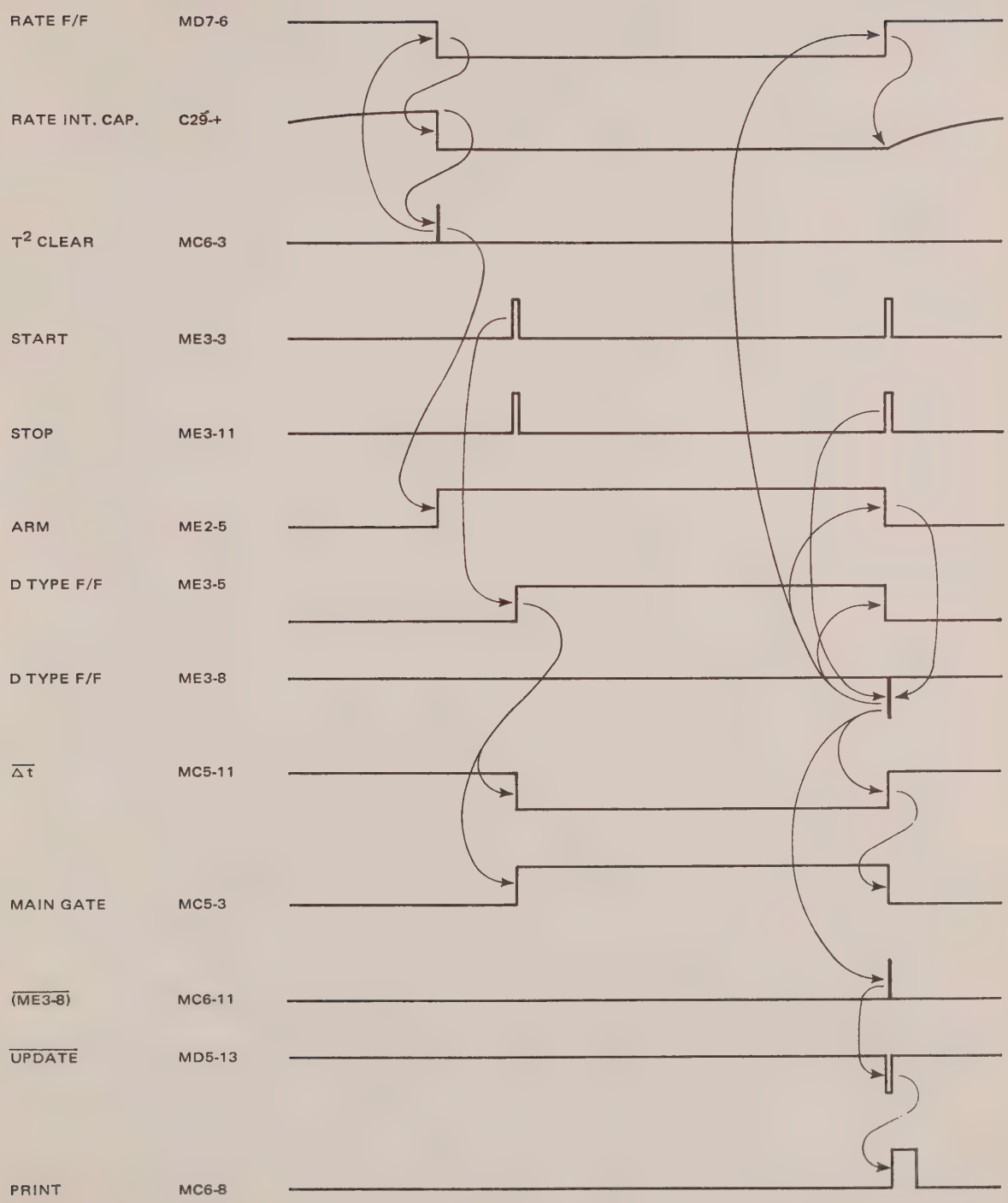


Figure 4.11 - Timing Diagram - Executive Logic (8010B, 8020B, 8030B)

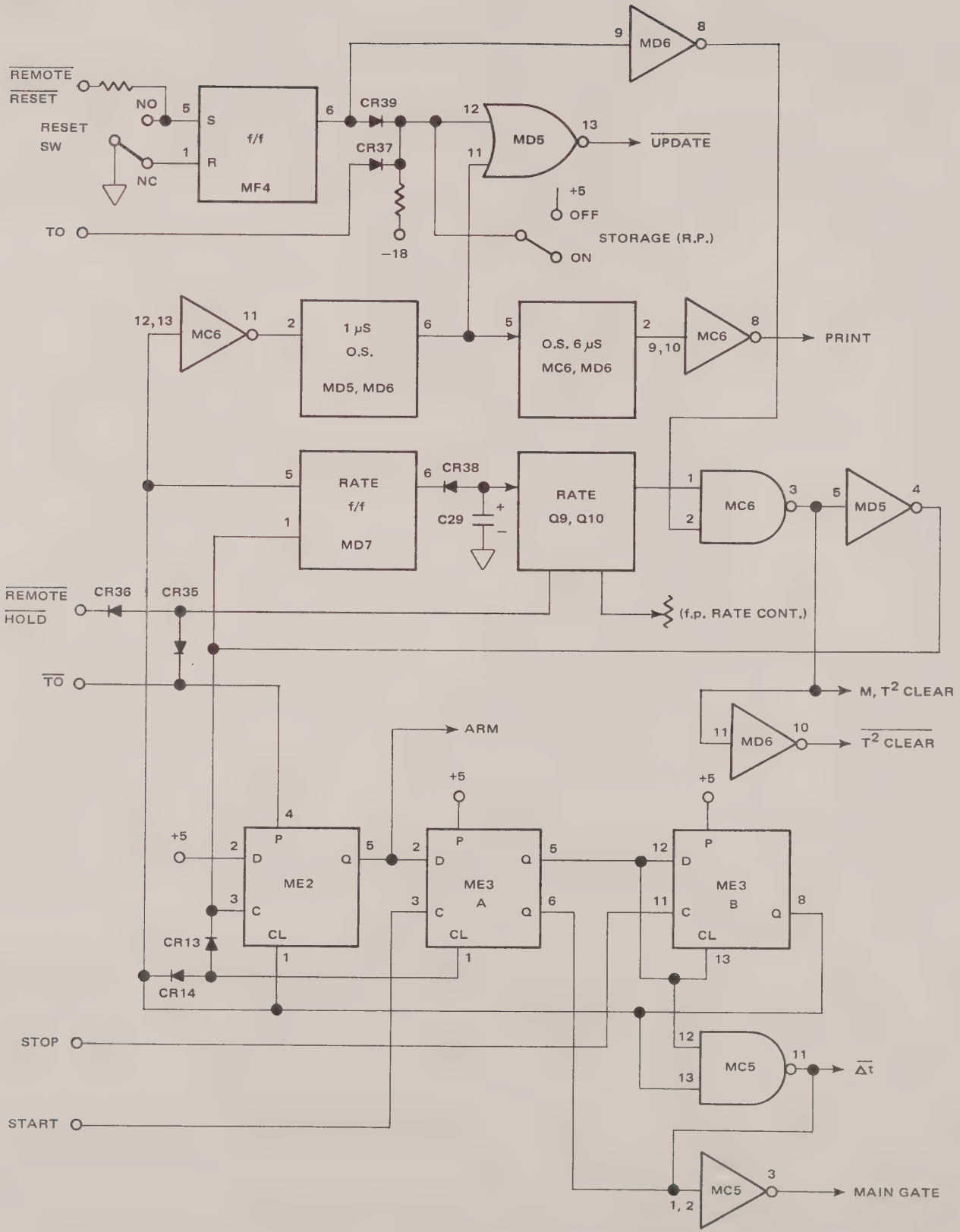


Figure 4.12 - Block Diagram Executive Logic (8010B, 8020B, 8030B)

4.23 EXECUTIVE LOGIC. This circuitry controls the timing sequence for the rest of the instrument and generates the control signal ($\overline{\Delta t}$) for the gated counter.

4.24 MODELS 8010B, 8020B, 8030B. The timing sequence is illustrated in the timing diagram of figure 4.11 and the circuitry is shown simplified in figure 4.12. With the front panel RATE control set to produce periodic readings (not in the HOLD position). The instrument operating sequence for all modes but TOTALIZE begins when MD7-6 goes false. The rate integrating capacitor C29 charges at a rate dependent on the setting of the front panel control and when the voltage across C29 reaches approximately +3.7 volts, a latching circuit consisting of transistors Q9 and Q10 fires. Gate output MC6-3 goes true and inverter output MD5-4 goes false, resetting the rate flip/flop. The voltage across C29 is discharged, the rate circuit is reset, and MC6-3 goes false. From the previous reading, ME2-5 is false, ME3-5 is false and ME3-8 is true. An inverted T^2 CLEAR pulse (MC6-3), generated by the rate circuit, is fed to the clock input of ME2-3 and sets ARM (ME2-5) true, and the instrument is now ready to measure. A START pulse to ME3-3 (clock) sets ME3-5 true, causing $\overline{\Delta t}$ to go false (MC5-11) and MAIN GATE (MC5-3) to go true and enables ME3B so it will respond to the next STOP pulse.

4.25 When a STOP pulse is received at ME3-11 (clock), ME3-8 goes false causing $\overline{\Delta t}$ to go true and MAIN GATE to go false. The same ME3-8 signal is inverted by MC6 and fires the 1 μs one-shot. The output of the one-shot is inverted through MD5 to produce the $\overline{\text{UPDATE}}$ pulse. At the same time, ME3-5 is reset false (through CR14 to ME3-1) which causes ME3-8 to reset true (through ME3-13). At the completion of the 1 μs one-shot, the 6 μs one-shot fires. The output is inverted to form the PRINT pulse (for Option 008).

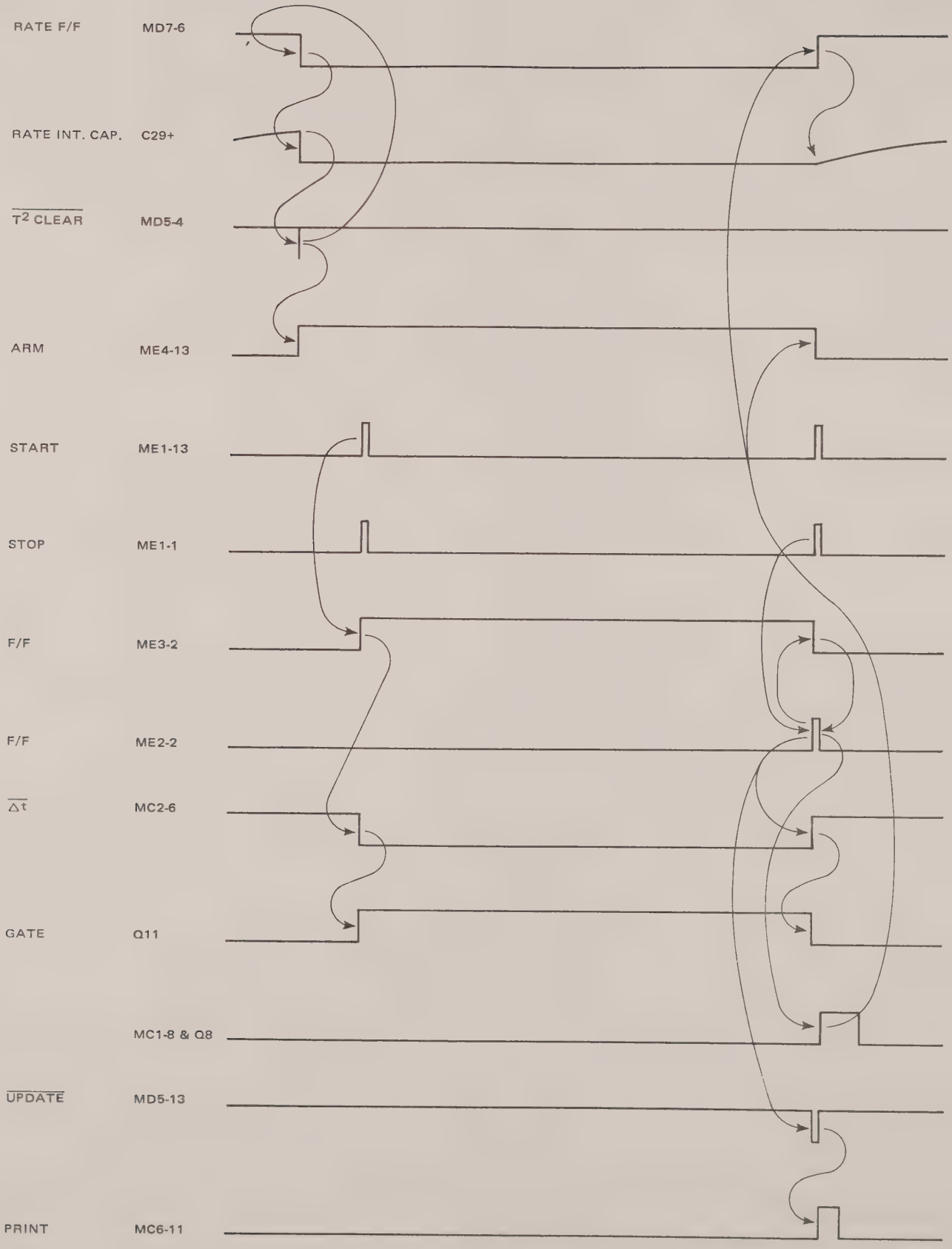


Figure 4.13 - Timing Diagram Executive Logic (8015B, 8035B)

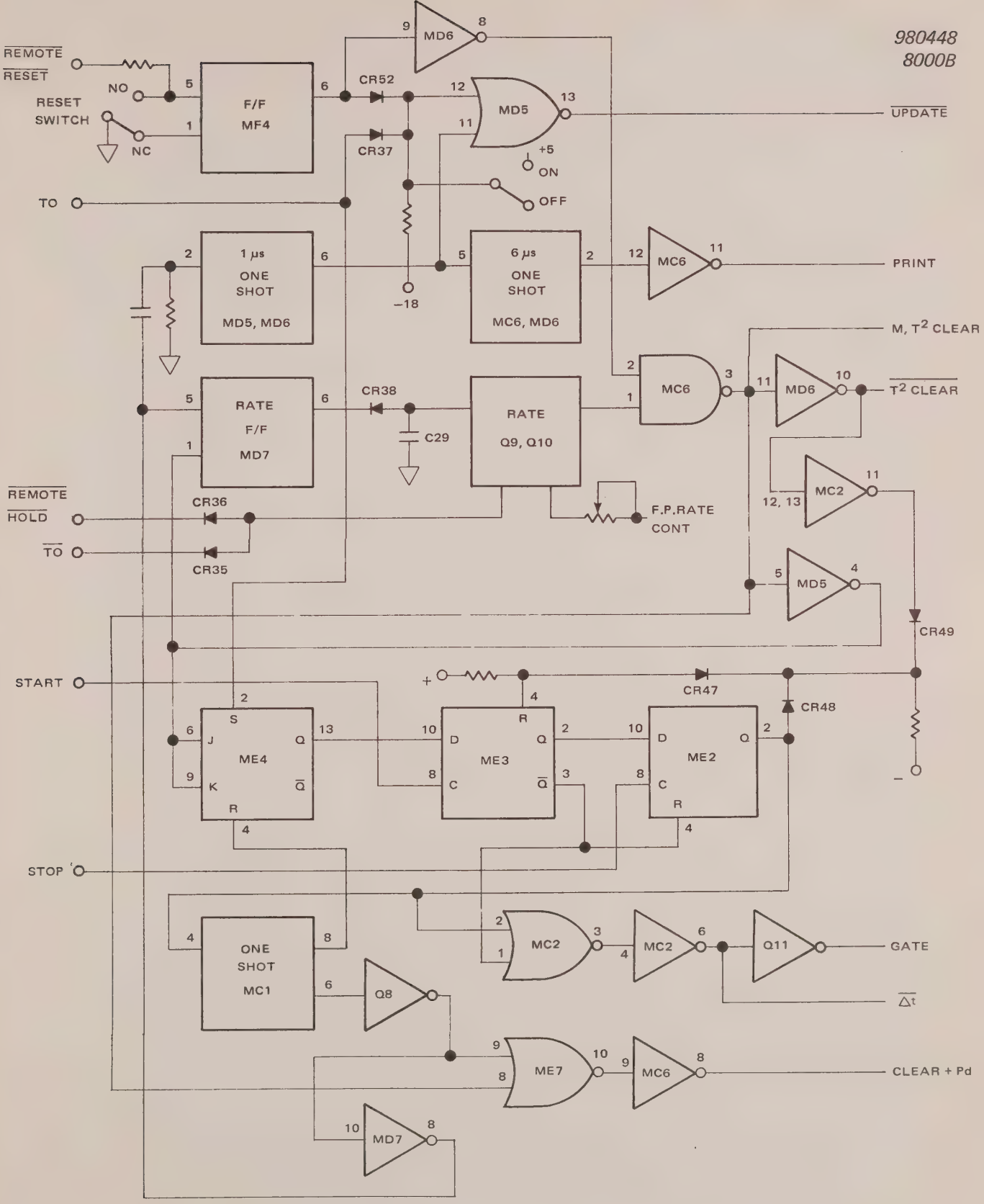


Figure 4.14 - Block Diagram Executive Logic (8015B, 8035B)

4.26 In the Totalize mode, the operation of the circuitry is the same with the following exceptions: The selection of Totalize sets MD5-11 true through CR37, causing MD5-13 to go false ($\overline{\text{UPDATE}}$). This allows the accumulation of pulses in the counter to be continuously monitored. Also, pin 4 of ME2 is held to ground, presetting Pin 5 of ME2 (ARM) to true and the rate circuit is disabled through CR35. The Start Stop pulses are generated manually by the START/STOP switch on the front panel or electrically through the external gate line ($\overline{\text{EXT. GATE}}$) and performs the same function as the internally generated pulses in the other measurement modes. However, since the ARM line is held true as long as the instrument is in the Totalize mode, the Totalize measurement may be started and stopped as many times as desired.

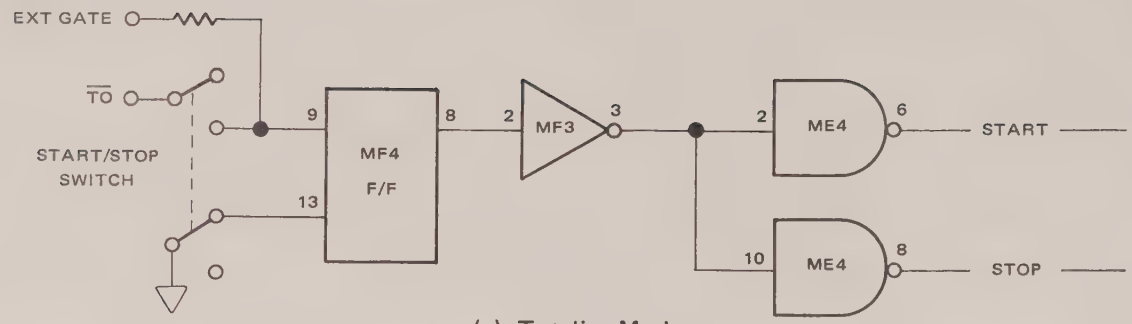
4.27 The reset circuit is used in the Totalize mode or when HOLD is selected to reset the Counter/Display circuitry and Time Base decades to zero. In Hold, for modes other than Totalize, the reset commands a new reading.

4.28 MODELS 8015B and 8035B. The timing sequence and simplified drawing are provided in figure 4.13 and 4.14. With the front panel RATE control set to produce periodic readings (not in the HOLD position), the instrument operating sequence for all models except Totalize begins when the rate flip/flop output (MD7-6) goes true. The rate integrating capacitor C29 starts charging at a rate dependent on the setting of the front panel control. When the voltage across the capacitor reaches approximately +3.7 volts, a latching circuit (consisting of transistors Q9 and Q10) fires. Gate output MC6-3 goes true (T^2 CLEAR) and inverter output MD5-4 goes false resetting the rate flip/flop. The voltage across C29 is discharged. The rate

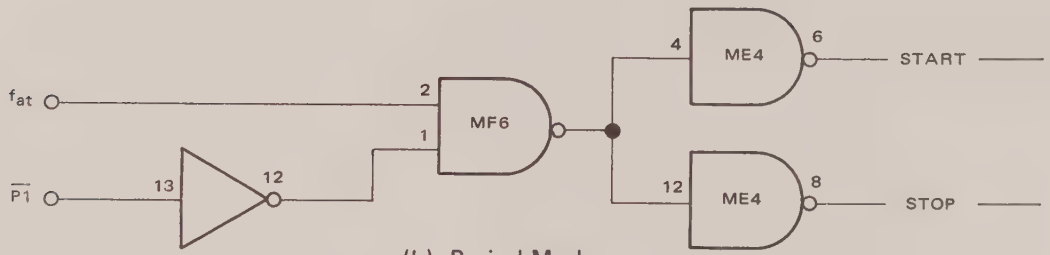
circuit is reset, and MC6-3 goes false. From the previous reading, ME4-13 is false, ME3-2 is false and ME2-2 is false. An inverted T^2 Clear pulse (MC6-3) is fed to the input of ME4 setting ME4-13 true. The instrument is now prepared to measure.

4.29 A START pulse to ME3-8 (clock) sets ME3-2 true which enables ME2 so it will respond to the next STOP pulse, causes $\overline{\Delta t}$ to go false (MC2-6) and MAIN GATE to go true (Q11). When a STOP signal is received at ME2-8 (clock) ME2-2 goes true resetting ME3-2 false through diodes CR48 and CR47, and causing $\overline{\Delta t}$ to go true and MAIN GATE to go false. The flip/flop output ME2-2 also generated a pulse through one-shot MC1 resetting ME4-13 false. A pulse from the one-shot through Q8 and MD7 resets the Rate flip/flop true (MD7-6) and fires a 1 μs one-shot. The one-shot output (MD6-6) passes through MD5 to produce the $\overline{\text{UPDATE}}$ and is applied to the input of a 6 μs one-shot. The 6 μs one-shot output (MD6-2) is inverted and is the PRINT pulse.

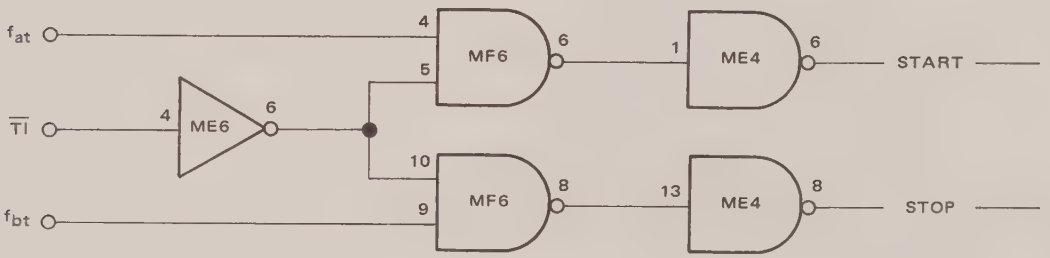
4.30 In the Totalize mode, the operation of the circuitry is the same with the following exceptions: the selection of Totalize sets MD5-12 through CR37, causing MD5-13 to go false ($\overline{\text{UPDATE}}$). This allows the accumulation of pulses in the counter to be continuously monitored. Also, pin 4 of ME2 is held true presetting ME2-13 true, and the rate circuit is disabled through diode CR35. The Start and Stop pulses are generated manually by the START/STOP switch on the front panel or electrically through the external gate line (EXT. GATE) and performs the same functions as



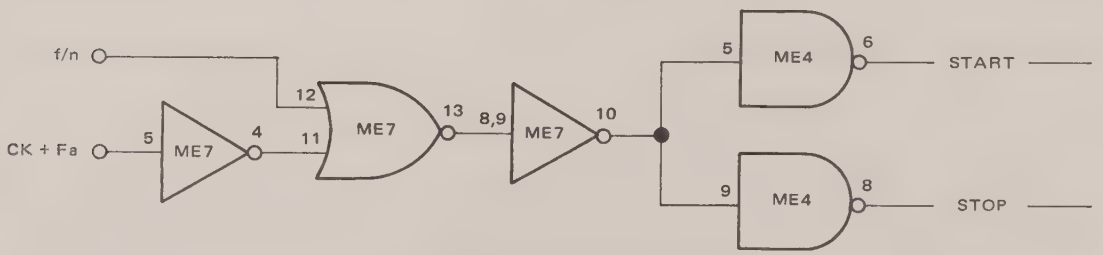
(a) Totalize Mode



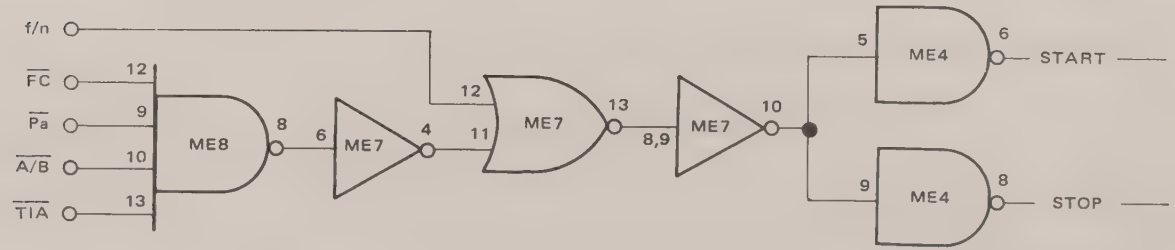
(b) Period Mode



(c) Time Interval Mode

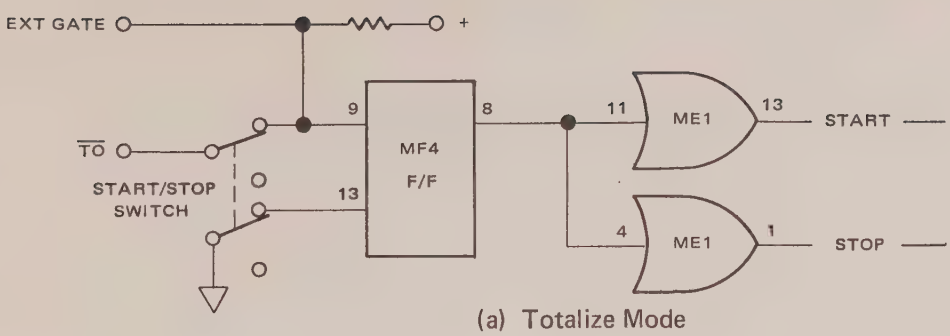


(d) Check or Freq A Mode

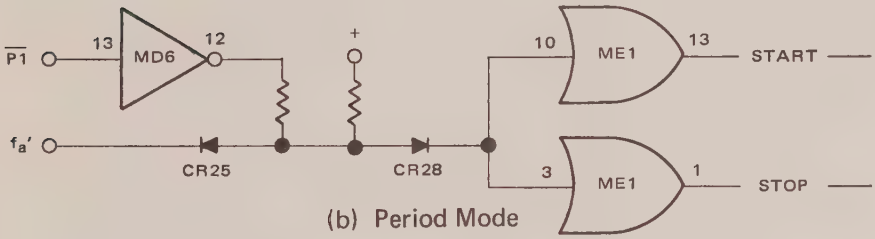


(e) Freq C, Period Average, Ratio, and Time Interval Average Modes

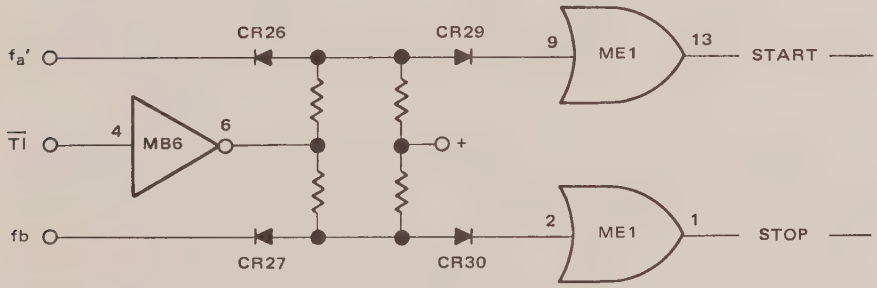
Figure 4.15 - Start/Stop Signal Flow 8010B, 8020B, 8030B



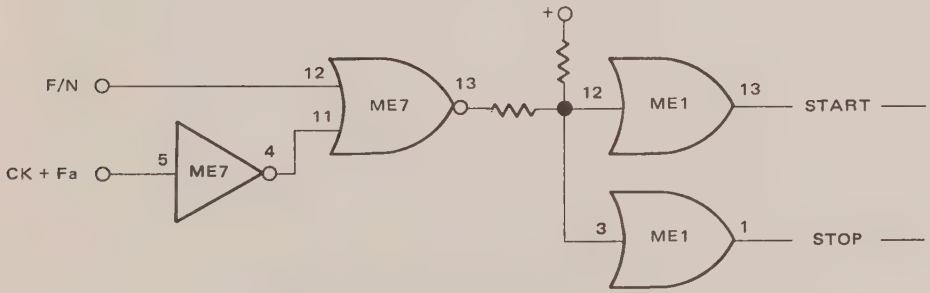
(a) Totalize Mode



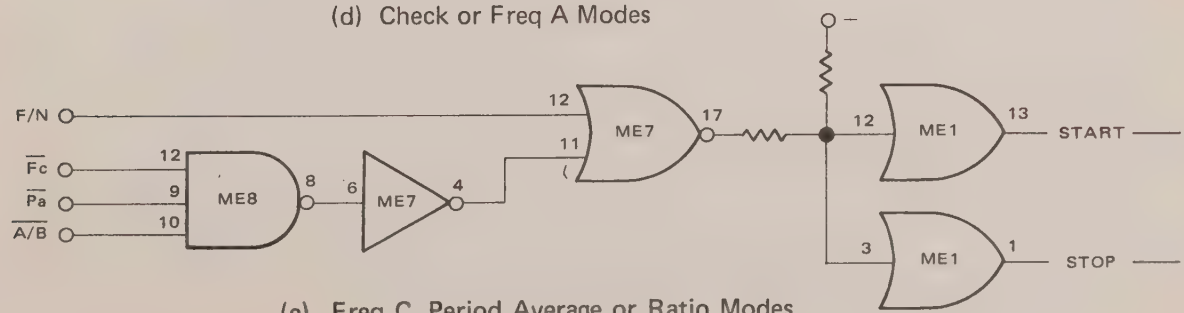
(b) Period Mode



(c) Time Interval Mode



(d) Check or Freq A Modes



(e) Freq C, Period Average or Ratio Modes

Figure 4.16 - Start/Stop Signal Flow (8015B, 8035B)

the internally generated pulses in the other measurement modes. However, since ME4-13 is held true as long as the instrument is in the Totalize mode, the totalize measurement may be started and stopped as many times as desired.

4.31 The reset circuit is used, in the Totalize mode or when HOLD is selected, to reset the Counter/Display circuitry and Timebase decades. With HOLD selected, the reset commands a new reading.

4.32 START/STOP. This circuitry generates pulses which, when processed by the executive logic circuitry, control the Gated Counter. The routing of signals according to measurement mode and model are shown in figures 4.15 and 4.16.

4.33 MARKER LOGIC. The MARKER output provides a negative 15 volt pulse during TIME INTERVAL measurement for increasing the intensity of an oscilloscope trace.

4.34 MODELS 8010B, 8030B. The circuit consists of two D-type flip/flops (ME1) driving a voltage level shift circuit (Q16, Q17). A Channel A input (f_{at}) sets ME1-6 false, producing a -15 volt output at the collector of Q17. A trigger from the Channel B input (f_{bt}) resets ME1-6 true causing the transistor Q17 to saturate and producing an output of about zero volts.

4.35 MODELS 8015B, 8035B. This circuit consists of an emitter coupled JK flip/flop (MF3) driving inverter Q20. A Channel A input (f_a') sets Q of the flip/flop true resulting in an output of approximately -18 volts. A trigger pulse from the Channel B input (f_b) sets Q of the flip/flop to false causing the transistor to saturate and producing an output of about zero volts.

4.36 The power supply (see READOUT schematic) provides all voltage levels for the operation of the instruments and standby power (with power OFF selected) for the

continuous operation of the optional frequency source (with instruments equipped with option 050). All supplies except the +150 volt supply are regulated.

4.37 Positive 150 Volt Supply. This voltage is used by the gas tube display and provided by a +250 volt full wave bridge circuit. A current limiting resistor R60 drops the voltage to the tubes to approximately +150 volts when the tubes are conducting. With power OFF the +150 line is opened.

4.38 Positive 28 Volt Supply. The 28 volts from this supply is used only for the optional frequency reference (option 050) and is derived from a tapped secondary full wave rectified circuit and an integrated 28 volt regulator.

4.39 Negative 18 Volt Supply. The negative 18 volt level is used throughout the instrument and is derived from a -28 volt full wave rectified supply and a regulator consisting of zener CR20 and transistors Q26 and Q101. Referring to the schematic, Q26 and CR20 (18 volt zener) form a 12 milliamp current generator with resistors R66 and R67 supplying current to the zener. The base of Q101 is driven by the current generator causing Q101 to conduct heavily pulling the output towards -28 volts through Diode CR22. At -18 volts diode CR21 starts conducting causing the current generator to lessen the output and at this point stability is reached. When the power switch is set to OFF the -18 volt supply is shorted to ground, more current than can be supplied by Q101, is drawn through CR22 thereby turning off the current generator Q20, and the output drops to zero. The current through the short (OFF position) is approximately equal to -28V/3.6K (R67).

4.40 Positive 18 Volt Supply. This level is also used throughout the instrument and is derived from a +28 full wave rectified circuit. The regulator circuit consisting of transistors Q27, Q28, Q103, and 18 volt zener CR23, operates in the same manner as the -18 volt supply. Transistor Q28 functions as a switch and turns off the +18 supply when the -18 volt supply goes to ground (instrument is shut off).

4.41 POSITIVE FIVE VOLT SUPPLY. The five volt level is used by all of the digital circuitry. The regulator operates in the same manner as the + and - 18 volt supplies but uses a 5 volt zener. The current for the zener is supplied through resistor R63 from the -18 volt supply.

SECTION 5

PERFORMANCE CHECK & CALIBRATION

5.1 INTRODUCTION.

5.2 This section describes the methods for checking and calibrating the counter.

5.3 Instrument Cover Removal.

5.4 To remove top and bottom covers, unscrew the four screws which secure cover to instrument.

> **WARNING**
>
> 115/230 VAC and +220 VDC supply lines are exposed when covers are removed. Remove power from instrument when possible by disconnecting from AC power source.

5.5 Assembly Designation and Location.

5.6 Assembly names and Dana part numbers of assemblies are listed in table 5.1.

Table 5.1 - Assembly Identification

ASSEMBLY NAME	PART NUMBER				
	8010B	8015B	8020B	8030B	8035B
Signal Conditioning Module	406654	406654	406654	406654	406654
Switch Board	406631	406151	406630	406632	406151
Readout	406145	406145	406145	406145	406145
Rear Panel	406580	406580	406580	406580	406580
500 MHz Prescaler	406120	406120	406120	406120	406120
Harness	406563	406563	406563	406563	406563

5.7 Performance Check.

5.8 Reference Oscillator Stability.

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	FREQ A
MULTIPLIER/TIME BASE	10 sec
SLOPE A	+
AC/DC	DC
RANGE	PRESET
SEP-COM	SEP
STORAGE	ON

b. After allowing one-half hour warm-up period connect 1 MHz Frequency Standard to A INPUT.

c. Offset between the Counter oscillator frequency and 1 MHz Frequency Standard can be determined by subtracting 10 MHz from the indicated display. Examples are shown in table 5.2.

Table 5.2 - Counter Time Base Error

DISPLAY	Counter Oscillator Frequency
999.9950 KHz	10000.050 KHz
999.9975	10000.025
1000.0000	10000.000
1000.0025	9999.975
1000.0050	9999.950

d. To calibrate the counter to the Frequency Standard, use an insulated tuning tool to adjust the COARSE and FINE controls on the rear panel until the display reads 1000.0000 KHz.

e. To determine long term stability, operate the counter continuously for at least 1 month, and measure the frequency offset at one month intervals.

f. To measure line voltage stability, use a Variac to vary the line voltage $\pm$ 10% and measure the frequency difference.

g. Check REF OUT by connecting the vertical axis of an oscilloscope to the REF OUT BNC connector on the rear panel. An output of >2.0V P-P in amplitude and 10 MHz in frequency should be present.

5.9 COUNTING DECADES AND MULTIPLIER/TIME BASE DECADES.

a. Set counter controls as follows:

DISPLAY TIME	Mid-position
FUNCTION	CHECK
STORAGE	OFF

b. Table 5.3 reflects proper operation of the decade counters.

Table 5.3

TIME BASE	DISPLAY
1 µs	00000010 ± 1 count
10 µs	00000100 ± 1 count
100 µs	00001000 ± 1 count
1 ms	00010000 ± 1 count
10 ms	00100000 ± 1 count
100 ms	01000000 ± 1 count
1s	10000000 ± 1 count
10s	*00000000 ± 1 count
100s	*00000000 ± 1 count

*All zeros should be observed at the conclusion of the counter main gate.

5.10 DECIMAL POINT LOGIC AND UNITS LOGIC.

a. Set FUNCTION to FREQ A

b. Set MULTIPLIER/TIME BASE as shown in table 5.4 and check for proper operation.

Table 5.4 - Decimal Point and Units Logic Check for FREQ A Mode of Operation

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
1 µsec	00000000	MHz
10 µsec	0000000.0	MHz
100 µsec	000000.00	MHz

Table 5.4 - Decimal Point and Units Logic Check for FREQ A Mode of Operation (Cont)

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
1 msec	00000.000	MHz
10 msec	0000.0000	MHz
100 msec	000.00000	MHz
1 sec	00.000000	MHz
10 sec	0000.0000	KHz
100 sec	000.00000	KHz

c. Set FUNCTION to FREQ C.

d. Set MULTIPLIER/TIME BASE as shown in table 5.5 and check for proper operation.

Table 5.5 - Decimal Point and Units Logic Check for FREQ C Mode of Operation

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
1 usec	00000000	MHz
10 usec	0000000.0	MHz
100 usec	000000.00	MHz
1 msec	00000.000	MHz
10 msec	0000.0000	MHz
100 msec	000.00000	MHz
1 sec	00.000000	MHz
10 sec	0.0000000	MHz
100 sec	.00000000	MHz

e. Set FUNCTION to PERIOD.

f. Set MULTIPLIER/TIME BASE as shown in table 5.6 and check for proper operation.

Table 5.6 - Decimal Point Logic and Units Logic Check for Period and Time Interval (8010B, 8030B) Modes of Operation

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
1	0000000.0	µsec
10	00000000	µsec
10^2	000000.00	msec
10^3	0000000.0	msec
10^4	00000000	msec
10^5	000000.00	sec
10^6	0000000.0	sec
10^7	00000000	sec
10^8	00000000	

g. Set FUNCTION to T.I.

h. Set MULTIPLIER/TIME BASE as shown in tables 5.6 and 5.7 and check for proper operation.

Table 5.7 - Decimal Point and Units Logic Check for Time Interval (8015B, 8035B) Modes of Operation

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
1	000000.00	μsec
10	0000000.0	μsec
10^2	00000000	μsec
10^3	000000.00	msec
10^4	0000000.0	msec
10^5	00000000	msec
10^6	000000.00	sec
10^7	0000000.0	sec
10^8	00000000	sec

i. Set FUNCTION to PER. AVG.

j. Set MULTIPLIER/TIME BASE as shown in table 5.8 and check for proper operation.

Table 5.8 - Decimal Point and Units Logic Check for Period Average Mode of Operation

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
1	0000.0000	msec
10	000.00000	msec
10^2	00.000000	msec
10^3	0000.0000	μsec

Table 5.8 - Decimal Point and Units Logic Check for Period Average Mode of Operation (Continued)

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
10^4	000.00000	µsec
10^5	00.000000	µsec
10^6	0000.0000	nsec
10^7	000.00000	nsec
10^8	00.000000	nsec

k. Set FUNCTION to T.I. AVG.

l. Set MULTIPLIER/TIME BASE as shown in tables 5.9 and 5.10 and check for proper operation.

Table 5.9 - Decimal Point and Units Logic Check for Time Interval Averaging (8010B, 8030B) Mode of Operation

MULTIPLIER/ TIME BASE	DISPLAY	UNITS
1	0000000.0	usec
10	000000.00	usec
10^2	00000000	nsec
10^3	0000000.0	nsec
10^4	000000.00	nsec
10^5	00000.000	nsec
10^6	0000.0000	nsec
10^7	000.00000	nsec
10^8	00.000000	nsec
10^9	0.0000000	nsec

5.11 INPUT CONTROLS AND MARKER.

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	FREQ A
MULTIPLIER/TIME BASE	1 sec
SLOPE A	-
SLOPE B	-
AC/DC A	AC
AC/DC B	AC
INPUT VOLTAGE A	1
INPUT VOLTAGE B	PRESET
SEP/COM	COM
STORAGE	ON

b. Connect a BNC "T" connector to INPUT A.

c. Connect Test Oscillator output and Oscilloscope vertical input to T connector.

d. Connect Counter MARKER to Oscilloscope Z-axis input.

e. Adjust Test Oscillator output to 100 Hz at 4V P-P.

f. Vary A trigger level control and verify that the marker initiation is variable over at least +3 volts to -3 volts on the negative slope and that the marker termination is 0 $\pm$ 50 mVDC on the positive slope.

g. Change INPUT A from 1 to PRESET and INPUT B from PRESET to 1.

h. Vary B trigger level control and verify that the marker termination is variable over at least +3 volts to -3 volts on the negative slope and that the marker initiation is 0 $\pm$ 5 mVDC on the positive slope.

5.12 FREQUENCY RESPONSE AND SENSITIVITY.

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	FREQ A
MULTIPLIER/TIME BASE	1 sec
SLOPE A	+
AC/DC	AC
INPUT VOLTAGE A	1
SEP/COM	SEP
STORAGE	ON

b. Connect a BNC T connector to INPUT A.

c. Connect Test Oscillator output and Oscilloscope vertical input to T connector. Use a 50 ohm termination at Oscilloscope input.

d. Adjust Test Oscillator output frequency from 10 Hz to 10 MHz, maintaining 150 mV P-P amplitude. With proper adjustment of A trigger level control the counter should display all frequencies in the above range.

e. Set MULTIPLIER/TIME BASE to 10 sec.

f. Set Test Oscillator frequency to 2 Hz. Counter should not count. Change AC/DC switch to DC. Counter should count input signal.

g. Replace Test Oscillator with a VHF Signal Generator. Remove BNC T connector and Oscilloscope from test set-up.

h. Set Signal Generator to 75 MHz at 50 mV RMS. Measure Signal amplitude with a 50 ohm terminated Sampling Voltmeter at end of coax cable that connects to Counter input.

i. Vary Signal Generator from 10 MHz to 75 MHz. With proper adjustment of A trigger level control the counter should display all frequencies in this range.

j. Set Signal Generator to 150 MHz at 100 mV RMS using same method in h.

k. Vary Signal Generator from 75 MHz to 150 MHz. With proper adjustment of A trigger level control the counter should display all frequencies in this range.

l. Change FUNCTION to FREQ C.

m. Connect Signal Generator to INPUT C.

n. Vary Signal Generator output from 1 mV RMS to 1V RMS in amplitude and 10 MHz to 500 MHz in frequency.

o. Counter should display all frequencies in this range.

5.13 PULSE OPERATION.

a. Set counter controls as indicated in 5.5a.

b. Connect a BNC T connector to INPUT A.

c. Connect Pulse Generator output and Oscilloscope vertical input to T connector. Use a 50 ohm termination at Oscilloscope input.

d. Adjust Pulse Generator output to 100 MHz repetition rate, 4 nanoseconds pulse width at 150 mV P-P.

e. Vary Pulse Generator repetition rate from 10 KHz to 125 MHz. With proper adjustment of A trigger level control the counter should display the above frequencies.

5.14 TOTALIZE.

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	TOTALIZE
MULTIPLIER/TIME BASE	1
INPUT VOLTAGE A	PRESET

b. Connect Test Oscillator to INPUT A and adjust output for 1 MHz at 1V RMS.

c. Connect Oscilloscope vertical input to SCALED OUT on rear panel.

d. Push RESET. Display should reset to zero.

e. Push START/STOP. Display should totalize.

f. SCALED OUT should be a pulse train with amplitude of more than 2V P-P and repetition rate of $f_a/(10N)$ where N is the MULTIPLIER/TIME BASE setting. For example, with Test Oscillator frequency of 1 MHz and a MULTIPLIER/TIME BASE setting of 10^2 the repetition rate of SCALED OUT should be 10 KHz.

g. Push START/STOP. Totalizing should stop and accumulated count should be displayed.

h. Push RESET. Display should be zero.

5.15 PERIOD AND PERIOD AVERAGE.

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	PERIOD
MULTIPLIER/TIME BASE	1
INPUT VOLTAGE	PRESET

b. Connect Test Oscillator to INPUT A and adjust output for 1V RMS.

c. Vary Test Oscillator frequency between 10 Hz and 10 MHz. Counter should display the period of the frequencies in this range within accuracy of instrument.

d. Set FUNCTION to PER. AVG. and MULTIPLIER/TIME BASE to 10.

e. Repeat step c.

5.16 A/B (RATIO)

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	A/B
MULTIPLIER/TIME BASE	10^6
SLOPE (A and B)	+
AC/DC (A and B)	AC
INPUT VOLTAGE (A and B)	1
SEP/COM	COM
STORAGE	ON

b. Connect a BNC T connector to INPUT A.

c. Connect Test Oscillator output and Oscilloscope vertical input to T connector. Use a 50 ohm termination at Oscilloscope input.

d. Adjust Test Oscillator output to 10 MHz at 100 mV RMS.

e. Vary B trigger level control until GATE is indicated.

f. Vary A trigger level control until Counter displaces reading.

g. Counter should display the multiplier setting within accuracy of instrument.

5.17 TIME INTERVAL AND TIME INTERVAL AVERAGING.

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	TI
MULTIPLIER/TIME BASE	1
SLOPE (A and B)	+
AC/DC (A and B)	AC
INPUT VOLTAGE A	PRESET
INPUT VOLTAGE B	1
SEP/COM	COM
STORAGE	ON

b. Connect a BNC T connector to INPUT A.

c. Connect Pulse Generator output and Oscilloscope vertical input to T connector. Use a 50 ohm termination at Oscilloscope input.

d. Adjust Pulse Generator output to 1 MHz repetition rate, 100 nanoseconds pulse width at 1V P-P (for models 8015B and, 8035B, use 10 nanoseconds pulse width).

e. With proper adjustment of B trigger level control the counter should display the repetition rate period.

f. Set SLOPE B to -. Counter should display pulse width within accuracy of instrument.

g. Function to TI AVG. and MULTIPLIER/TIME BASE to 10^3.

h. Repeat steps e and f.

5.18 DISPLAY TIME AND GATE OUTPUT.

a. Connect Counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	TOTALIZE

b. Connect Oscilloscope vertical input to GATE output on rear panel.

c. Press RESET and check that gate output is low.

d. Press START/STOP and check that gate output is > 2 volts.

e. Preset START/STOP and check that gate output is low.

f. Set FUNCTION to FREQ A and MULTIPLIER/TIME BASE to 100 msec.

g. Vary DISPLAY TIME and check that repetition rate changes from approximately 20 milliseconds to 5 seconds.

5.19 RECORDER OUTPUT.

a. Set counter controls as follows:

DISPLAY TIME	Mid-position
FUNCTION	CHECK
MULTIPLIER/TIME BASE	1 sec
STORAGE	ON

b. Connect Oscilloscope vertical input to J112-S and verify that a 5 volt, 6 microseconds display pulse occurs after each GATE.

c. Verify proper operation by connecting a printer or voltage sensing device such as an oscilloscope, voltmeter or logic probe to J111 and 112 and performing test in table 5.3.

5.20 REMOTE PROGRAMMING.

a. Set counter controls as follows:

DISPLAY TIME	power-on/CCW position
FUNCTION	REMOTE
AC/DC (A and B)	AC
INPUT VOLTAGE A	PRESET
INPUT VOLTAGE B	PRESET
SEP/COM	COM
STORAGE	ON

b. Connect J110 pins D, 1, L, P to pin 15.

c. Connect a BNC T connector to INPUT A.

d. Connect Pulse Generator output and Oscilloscope Channel A input to T connector. Use a 50 ohm termination at Oscilloscope input.

e. Adjust Pulse Generator output to 1 MHz repetition rate, 100 nanoseconds pulse width at 1V P-P.

f. Counter should display the repetition rate of Pulse Generator. Verify that MULTIPLIER/TIME BASE switches on front panel do not effect reading.

g. Disconnect J110-L from J110-15 and connect J110-M to J110-15. Counter should display pulse width of Pulse Generator.

h. Disconnect J-110-P from J110-15 and connect J110-R to J110-15. Counter should display repetition rate of Pulse Generator.

i. Replace Pulse Generator with Test Oscillator.

j. Using 10:1 Divider Probe connect Oscilloscope Channel B input to E1 located on Switch Board Assembly.

k. With Oscilloscope synchronized to Channel A and Test Oscillator output set to 1 KHz at 1V P-P verify that trigger point is 0 ± 50 mVDC.

l. Set INPUT VOLTAGE A to 1 and connect a DC voltage source to J110-S with common connected to J110-15.

m. Vary DC voltage measured a J110-S from +1 to -1 volt and verify that trigger point remains within ± 50 mVDC of DC voltage.

n. Repeat steps j through m except connect Oscilloscope Channel B input to E5 of Switch Board Assembly and DC voltage source to J110-N.

5.21 CALIBRATION.

5.22 SIGNAL CONDITIONING MODULE.

a. Set controls to the following positions:

SLOPE A:	+
SLOPE B:	+
AC/DC:	AC
TRIGGER LEVEL:	PRESET
RANGE:	1
SEP-COM:	COM

b. Apply an input signal of 100 mV (rms), 1 KHz to input A. Adjust R17 for counter operation indicated by numbers appearing on the readout.

c. Decrease input signal level and adjust R20 for maximum sensitivity.

d. Remove trigger level from PRESET and adjust trigger level for maximum sensitivity. Check analog output voltage (should be less than .04 vdc).

e. Increase input frequency to 150 MHz and input signal to maximum amplitude (1V rms).

f. Set trigger level to PRESET. Adjust R17 for proper display on readout panel.

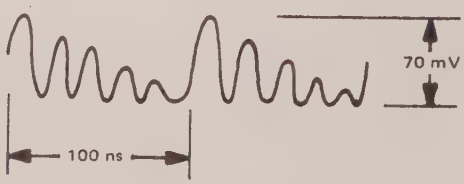
g. Repeat the above steps with input applied to Channel B. Adjust R20A in step c and R17A in steps b and f.

5.23 500 MHz PRESCALER.

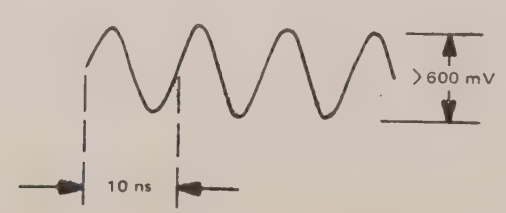
5.24 On certain instruments, a pot (R36) is included on this assembly. This pot should be set to its extreme clockwise position.

5.25 REFERENCE ADJUSTMENT (10 nsec, Models 8015B and 8035B only).

a. Connect scope between the emitter of Q18 and ground. Adjust C54 for the following waveform.



b. Connect scope between reference output at E7 and ground (E8). Adjust C56 for a 100 MHz signal of an amplitude greater than 600 mV peak-to-peak. See waveform below.



SECTION 6

REMOTE PROGRAMMING AND BCD OUTPUT

6.1 REMOTE PROGRAMMING.

6.2 Remote programming commands are received through J110, the REMOTE connector on the rear panel. Commands are generated by a closure to common, J110 - pin 15, from any of the single command lines. Pin assignments of J110 are listed in table 6.1.

6.3 Pins A through K of J110 are lines corresponding to the FUNCTION (operating mode) switch on the front panel. To remotely program any of the operating modes, the FUNCTION switch must be in the REMOTE position. The mode is then programmed by a closure to J110 - pin L from the appropriate pin.

6.4 Pins 1 through 10 of J110 are single lines corresponding to each of the MULTIPLIER/TIME BASE pushbutton switches. The lines program either a multiplier or a time base depending on the operating mode:

a. In Check mode, Frequency A and Frequency C modes, a command on one of the lines select the gate time.

b. In Period mode, a command selects the reference frequency to be counted.

c. In Period Average mode, a command selects the number of periods to be averaged.

d. In Totalize mode, a command selects the scaling factor of the scaled output.

e. In Time Interval mode, a command selects the reference frequency to be counted during the time interval A to B.

f. In Ratio mode (A/B), a command selects the number of periods of f_b input to be used as gate time.

Table 6.1 - REMOTE Programming Connector* J110

Pin	Command
A	Frequency C
B	Time Interval Average
C	Self Check
D	Time Interval
E	Period
F	Frequency Ratio A/B
H	Period Average
J	Totalize
K	Frequency A
L	Remote
M	Channel B Slope
N	Channel B Trigger Level
P	Channel A Slope
R	Not Used
S	Channel A Trigger Level
1	1
2	10^1 or 1 μsec
3	10^2 or 10 μsec
4	10^3 or 100 μsec
5	10^4 or 1 msec
6	10^5 or 10 msec
7	10^6 or 100 msec
8	10^7 or 1 sec
9	10^8 or 10 sec
10	10^9 or 100 sec
11	HOLD
12	RESET
13	Ext. Gate
14	Not Used
15	Common

*For models 8015B and 8035B in Time Interval mode, see table 6.1a.

g. In Time Interval Average mode, a command determines the number of intervals to be averaged.

6.5 The INPUT CONTROLS and the "+/–" switch on the front panel are duplicated by lines on pins M through S of J110. For remote programming of these functions, the INPUT CONTROLS potentiometer must be in the PRESET position. The trigger level is then controlled by the voltage applied to J110-S (Channel A Trigger Level) and pin N (Channel B Trigger Level). The value of the external voltage applied to pin S and N to obtain a particular trigger level must be calculated according to the following formula:

$$V_P = 10 \left(\frac{TL}{R}\right)$$

Where V_P = external programming voltage

TL = desired trigger level

R = range

Example 1: To obtain a trigger level of .7 volt on the 1-volt range,

$$V_P = 10 \left(\frac{.7}{1}\right) = 7 \text{ volts}$$

Example 2: To obtain a trigger level of 50 volts on the 100-volt range,

$$V_P = 10 \left(\frac{50}{100}\right) = 5 \text{ volts}$$

6.6 The instrument triggers on the positive slope unless there is a closure from pin 15 to pin M (Channel B Slope) or P (Channel A Slope). A negative slope trigger is thus programmed.

6.7 The "Hold" line, pin 11 of J110, corresponds to the full clockwise position of the DISPLAY TIME control on the front panel. In Hold, the instrument will "freeze" the last measurement indefinitely. Another reading can be taken if pin 12, RESET (corresponding to the front panel RESET switch), is activated.

6.8 External Gate, J110 - pin 13, is used in Totalize mode to externally establish gate time during which f_a is counted.

6.9 BCD OUTPUT.

6.10 BCD outputs of the counter appear at the RECORDER connectors, J111 and J112, on the rear panel of the instrument. The data is delivered in 8-4-2-1 positive true format at TTL logic levels (approximately 0 to +0.4 volts for a logical false and +2.4 to +5.0 volts for a logical true). Outputs are referenced to J112 - pin 14, Zero Reference.

6.11 Table 6.2 shows the pin assignments of the RECORDER connectors. V1 through V9 represent the corresponding readout windows with V1 the least-significant bit. Each line is identified by its position (V1 through V9) followed by its binary weight. For example, a seven in the most-significant bit is shown as:

V9-8 J112, pin C = 0
V9-4 J112, pin B = 1
V9-2 J112, pin 3 = 1
V9-1 J112, pin 2 = 1

6.12 Pins D through K of J112 correspond to the annunciators on the readout panel. They identify the units of time or frequency in which the measurement is expressed.

6.13 Pins 4 through 11 define the position of the decimal point. The lines, DP1 through DP8, indicate the number of places to the left of the rightmost digit at which the decimal point is placed.

6.14 The Print command is a +5-volt pulse of 6-μsecond duration appearing at J112 - pin S indicating that the current measurement is at a final value and the data can be printed.

6.15 An output at J112 - pin 15, One Reference, is for use with H/P printers requiring the additional reference level.

Table 6.1a - Models 8015B, 8035B — Time Interval Mode

J110

PIN	COMMAND
1	10^1 or 1 μsec
2	10^2
3	10^3
4	10^4
5	10^5
6	10^6
7	10^7
8	10^8
9	10^9
10	
11	HOLD
12	RESET
13	EXT. GATE
14	1
15	COMMON

Assignments of pins A thru S are same as in table 6.1.

Table 6.2 - RECORDER Output Connectors - J111 and J112

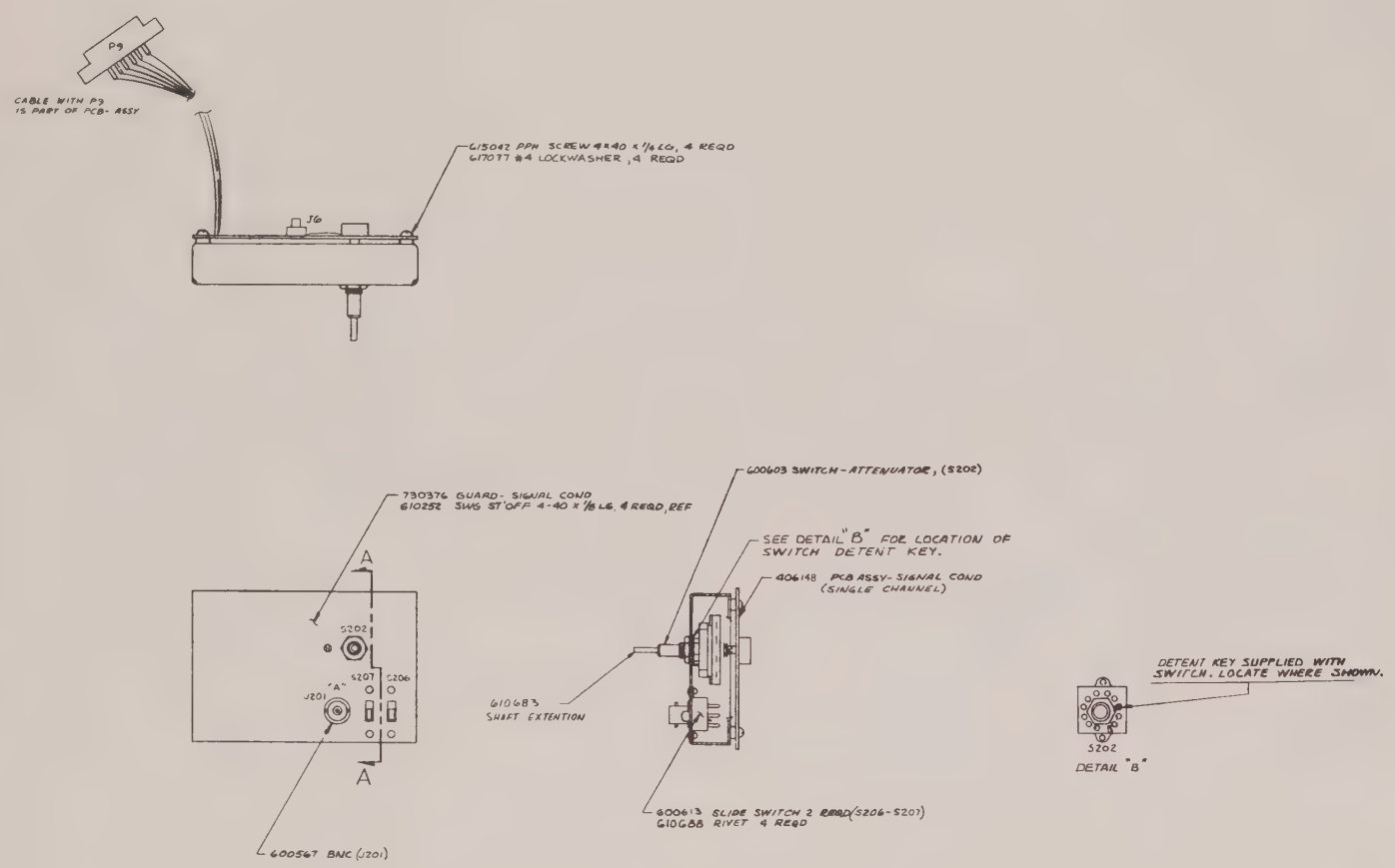
J111 Pin No.	Output	J112 Pin No.	Output
A	V1-4	A	V8-8
B	V1-8	B	V9-4
C	V2-4	C	V9-8
D	V2-8	D	MHz
E	V3-4	E	KHz
F	V3-8	F	Seconds
H	V4-4	H	Nanoseconds
J	V4-8	J	Milliseconds
K	V5-4	K	Microseconds
L	V5-8	L	Not Used
M	V6-4	M	
N	V6-8	N	
P	V7-4	P	
R	V7-8	R	
S	V8-4	S	Print
1	V1-1	1	V8-2
2	V1-2	2	V9-1
3	V2-1	3	V9-2
4	V2-2	4	DP1
5	V3-1	5	DP2
6	V3-2	6	DP3
7	V4-1	7	DP4
8	V4-2	8	DP5
9	V5-1	9	DP6
10	V5-2	10	DP7
11	V6-1	11	DP8
12	V6-2	12	Not Used
13	V7-1	13	
14	V7-2	14	Zero Reference
15	V8-1	15	One Reference

SECTION 7

DRAWINGS

7.1 DRAWINGS.

Assy., Signal Conditioning Module	406655
Schematic, Attenuator	721150
PCB Assy., Signal Conditioning Module	406148
Schematic, Signal Conditioning Module	721148
Assy., Rear Panel	406580
PCB Assy., Interconnection	406128
PCB Assy., Switch	406630
Schematic, Switch	721630
PCB Assy., Readout	406145
Schematic, Readout	721145
Harness Assy., Remote & Recorder	406563
PCB Assy., 500 MHz Prescaler	406120
Schematic, 500 MHz Prescaler	721120
Rear Input, Option 010	406661



SECTION A-A

3. REF DESIGNATORS SHOWN FOR IDENTIFICATION PURPOSE ONLY.
2. SCHEMATIC REF NO 721148, 721150
1. FOR WIRING OF MODULE SEE SHT. 2 THIS DWG.

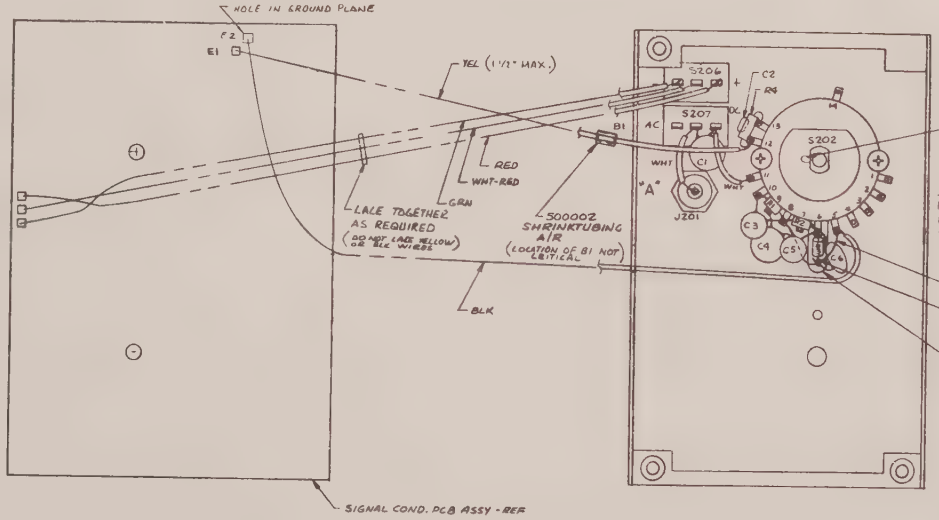
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY-MODULE, SIGNAL COND (SINGLE CHANNEL)

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	406655	B

SCALE 1/1 SHEET 1 OF 4



VIEWED INTO OPEN MODULE

COMP.	VALUE	COMP.	VALUE
R1	909K	C1	.01
R2	90.9K	C2,6	47PF
R3	10K	C3,5	5PF
R4	100K	C4	33PF

WIRING TO PCB-ASSY 406198 SIGNAL COND
ALL WIRES 24GA, COATED

CHANNEL "A"					
S206	524555	GRN	4" LG	- SLOPE	E9
S206	524929	WHT-RED	4" LG	SLOPE	E10
S206	524922	RED	4" LG	+ SLOPE	E11
S202-5	524000	BLK	3" LG	GND	E2
S202-12	524444	YEL	2" LG	Fa	E1

BUNDLE WIRES FROM MODULE TO PCB WITH TIE CORD 500006 AS REQUIRED.

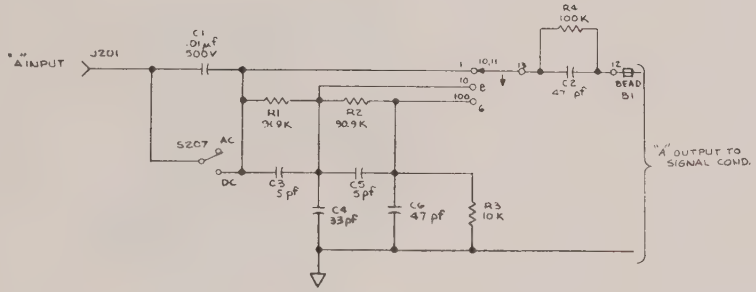
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY-MODULE, SIGNAL COND. (SINGLE CHANNEL)

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	406655	B

SCALE NONE SHEET 2 OF 4



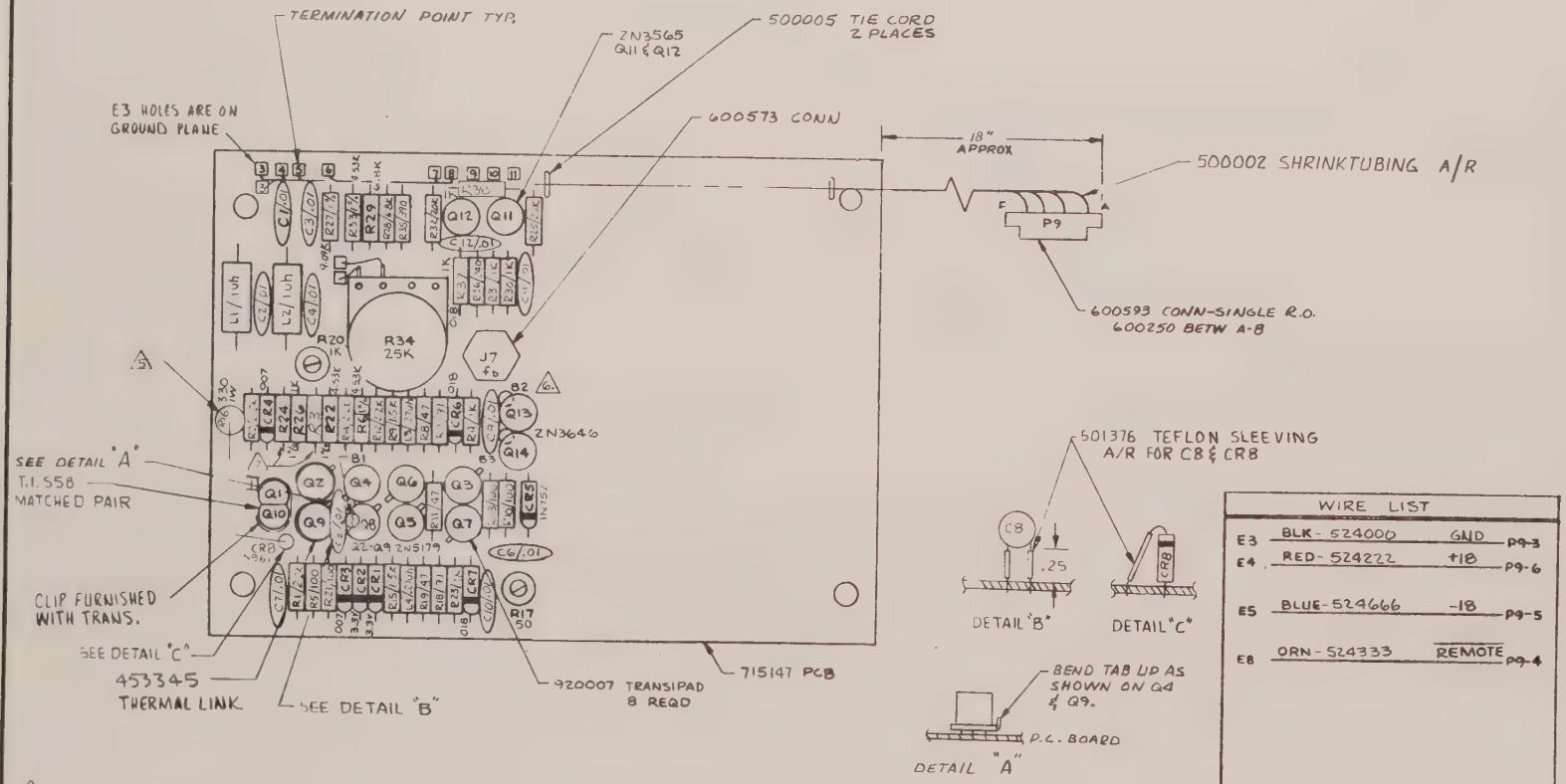
3. REF NO 406655 MODULE ASSY.
2. CAP VALUES ARE IN MICROFARADS.
1. RES VALUES ARE IN OHMS ± 5%, ¼ WATT.

NOTES UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - SIGNAL COND., ATTENUATOR, SINGLE

SIZE	VENDOR ASSEMBLY NO.	DWG. NO.	REV
D	21793	721150	A
SCALE NONE		SHEET 1 OF 1	



WIRE LIST			
E3	BLK - 524000	GND	P9-3
E4	RED - 524222	+18	P9-6
E5	BLUE - 524666	-18	P9-5
E8	ORN - 524333	REMOTE	P9-4

⚠1 R3 & R24 ARE 9.09K RN55C.

⚠2 FERRITE BEAD ON EMITTERS OF Q13 & Q14 AND BASE OF Q8

⚠3 ELEVATE R1 & 3/32" OFF P.C. BOARD, SLEEVE AS REQ'D.

4. REF SCHEMATIC 721148

3. ASSY PROCEDURES & PROCESSES TO CONFORM TO DANA WORKMANSHIP STDS.

2. ALL RESISTORS ARE 1/4 W, 5%.

1. ALL CAP VALUES ARE IN uF.

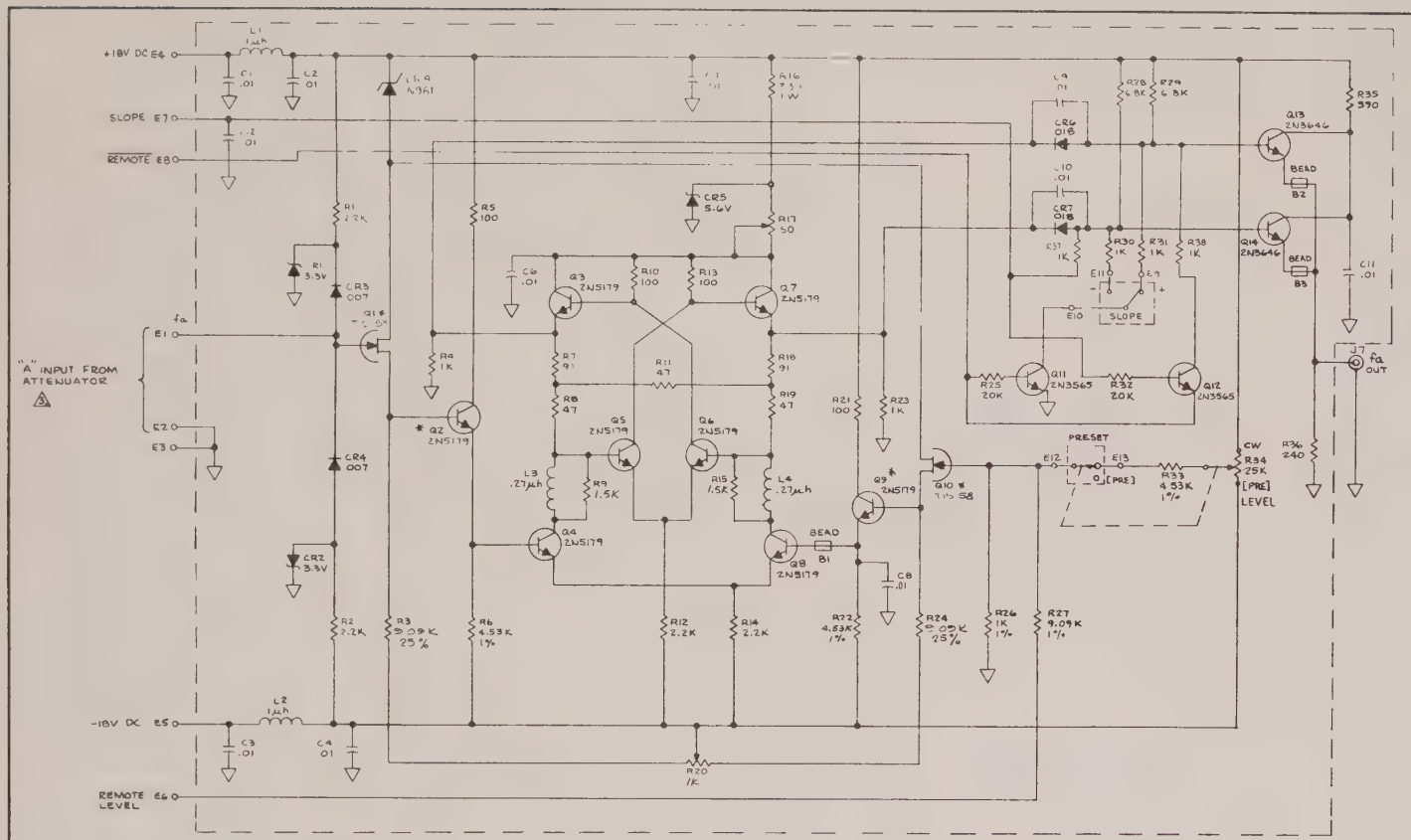
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

PCB ASSY-SIGNAL COND, SINGLE CHANNEL

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	406148	A

SCALE 2/1 SHEET 1 OF 4



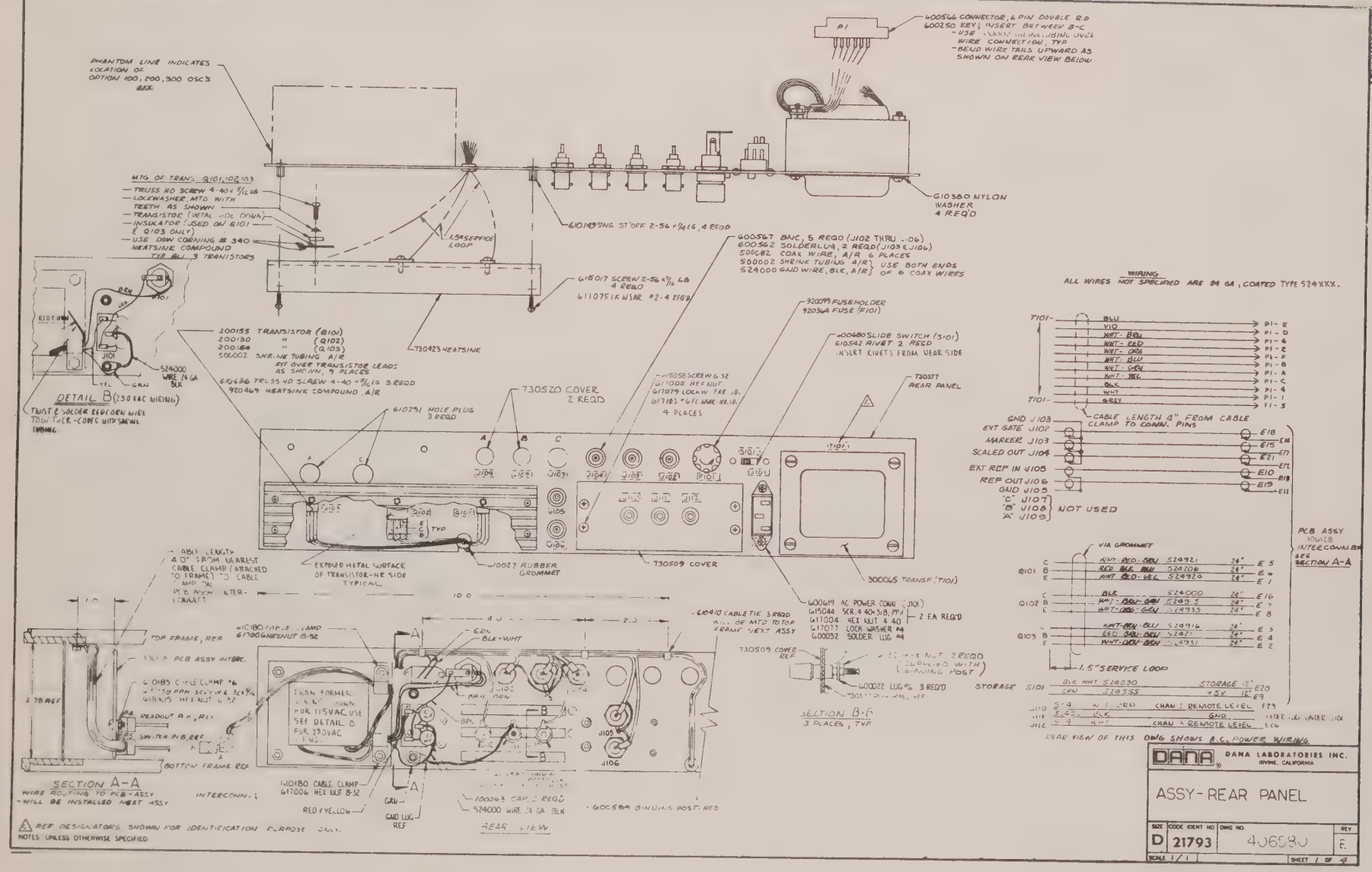
4. 1% RESISTORS ARE RN55D.
3. CAPS ARE IN μF, 100V.
2. RESISTORS ARE IN OHMS, ±5%, 1/4W.
1. * INDICATES MATCHED PAIR.
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – SIGNAL COND., SINGLE CHANNEL

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	721148	A

SCALE NONE | SHEET 1 OF 1

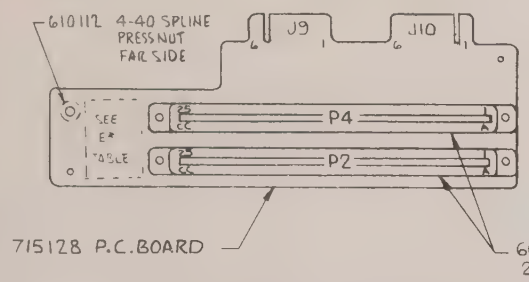

P1
600546 CONNECTOR, 6 PIN DOUBLE R.D
600250 KEY; INSERT BETWEEN B-C
- USE 300007 WIRE WRAPPING OVER WIRE CONNECTION, TYP.
- BEND WIRE TAILS UPWARD AS SHOWN ON REAR VIEW BELOW
PHANTOM LINE INDICATES LOCATION OF OPTION 100, 200, 300 OSC'S
MTG OF TRANS. Q101, 102, 103
- TRUSS HD SCREW 4-40 x 5/16 LG
- LOCKWASHER, MTD WITH TEETH AS SHOWN
- TRANSISTOR (METAL SIDE DOWN)
- INSULATOR (USED ON Q101 & Q103 ONLY)
- USE DOW CORNING # 340 HEATSINK COMPOUND TIP ALL 3 TRANSISTORS
1.5" SERVICE LOOP
610149 SWG STOFF 2-56 x 1/4 LG, 4 REQD
610380 NYLON WASHER 4 REQD
615017 SCREW 2-56 x 1/4 LG 4 REQD
611075 LK WSHR #2-4 REQD
730423 HEATSINK
600567 BNC, 5 REQD (J102 THRU J106)
600562 SOLDERLUG, 2 REQD (J103 & J106)
500682 COAX WIRE, A/R 6 PLACES
500002 SHRINK TUBING A/R } USE BOTH ENDS
524000 GND WIRE, BLK, A/R } OF 6 COAX WIRES
920099 FUSEHOLDER
920364 FUSE (F101)
600680 SLIDE SWITCH (S101)
610542 RIVET 2 REQD
INSERT RIVETS FROM REAR SIDE
730377 REAR PANEL
WIRING
ALL WIRES NOT SPECIFIED ARE 24 GA, COATED TYPE 524XXX.
T101-
BLU
V10
WHT - BRN
WHT - RED
WHT - ORN
WHT - BLU
WHT - GRN
WHT - YEL
BLK
WHT
GREY
T101-
P1 - E
P1 - D
P1 - C
P1 - B
P1 - A
P1 - F
P1 - 4
P1 - 1
J1 - 3
CABLE LENGTH 4" FROM CABLE CLAMP TO CONN. PINS
GND J103
EXT GATE J102
MARKER J103
SCALED OUT J104
EXT REF IN J105
REF OUT J106
GND J103
'C' J107
'B' J108
'A' J109
NOT USED
E18
E15
E17
E21
E11
E10
E13
E19
PCB ASSY 406128 INTERCONN SEE SECTION A-A
VIA GROMMET
Q101 C WHT-RED-BRN 524921 24" E5
B RED BLK BRN 524208 24" E6
E WHT RED-VIO 524920 24" E1
Q102 C BLK 524000 24" E16
B WHT-BRN-GRN 524933 24" E7
E WHT-ORG-GRN 524935 24" E8
Q103 C WHT-BRN-BLU 524916 24" E3
B RED GRN-BRN 524211 24" E4
E WHT-ORN-BRN 524931 24" E2
1.5" SERVICE LOOP
STORAGE S101 BLK WHT 524930 STORAGE 2" E20
CRN 524935 +5V 12" E9
J110 SIG A CHAN 1 REMOTE LEVEL F23
J111 BRAID GND UNDER J106 UNDER J101
J112 SIG A CHAN 2 REMOTE LEVEL E26
REAR VIEW OF THIS DWG SHOWS A.C. POWER WIRING.
DETAIL B (230 VAC WIRING)
TWIST & SOLDER RED/ORN WIRE TOGETHER - COVER WITH SHRINK TUBING
200155 TRANSISTOR (Q101)
200130 " (Q102)
200164 " (Q103)
500002 SHRINK TUBING A/R
PUT OVER TRANSISTOR LEADS AS SHOWN, 3 PLACES
610636 TRUSS HD SCREW 4-40 x 5/16 LG 3 REQD
920469 HEATSINK COMPOUND, A/R
730205 COVER 2 REQD
610251 HOLE PLUG 3 REQD
611008 HEX NUT 617079 LOCK WSHR #8 617103 6FL WSHR-HEX #8 4 PLACES
730509 COVER
EXPOSED METAL SURFACE OF TRANSISTOR-HEATSINK SIDE TYPICAL
610027 RUBBER GROMMET
300065 TRANSF (T101)
600619 AC POWER CONN (J101)
615044 SCR 4-40 x 3/8 PPH
617004 HEX NUT 4-40
617017 LOCK WASHER #4
600052 SOLDER LUG #4
2 EA REQ'D
CABLE LENGTH 4.0" FROM NEAREST CABLE CLAMP (ATTACHED TO FRAME) TO CABLE END ON PCB ASSY INTERCONNECT
610410 CABLE TIE 3 REQD
MAY BE MTD TO TOP FRAME NEXT ASSY
610180 CABLE CLAMP 617006 HEX NUT 8-32
TRANSFORMER CONNECTIONS FOR 115VAC USE SEE DETAIL B FOR 230VAC
SECTION B-B
3 PLACES, TYP
SECTION A-A
WIRE ROUTING TO PCB-ASSY - WILL BE INSTALLED NEXT ASSY
INTERCONN.:
TOP FRAME, REF
PCB ASSY INTERC.
610183 CABLE CLAMP #6 617005 PAN SCREW 6-32 x 3/8 610615 HEX NUT 6-32
READOUT P.C. REF
SWITCH PCB, REF
BOTTOM FRAME REF
2.78 REF
610180 CABLE CLAMP 617006 HEX NUT 8-32
RED/YELLOW
GRN
GND LUG REF
100063 CAP, 3 REQD
524000 WIRE 24 GA BLK
REAR VIEW
GRN-BLK-WHT
BRN-ORN
BRN
600584 BINDING POST-RED
730509 COVER REF
600022 LUG #6 3 REQD
REF DESIGNATORS SHOWN FOR IDENTIFICATION PURPOSE ONLY.
NOTES UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY - REAR PANEL

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	406890	E

SCALE 1/1 SHEET 1 OF 4



E # ASSIGNMENTS TO REAR PNL.

E #	FUNCTION
E1	Q101 EMITTER
E2	Q103 EMITTER
E3	Q103 COLLECTOR
E4	Q103 BASE
E5	Q101 COLLECTOR
E6	Q101 BASE
E7	Q102 BASE
E8	Q102 EMI
E9	+5
E10	EXT REF IN
E11	GROUND
E12	GROUND
E13	GROUND
E14	GROUND
E15	EXT GATE
E16	Q102 COLLECTOR
E17	GROUND
E18	MARKER
E19	REF OUT
E20	STORAGE
E21	SCALED OUT
E22	GROUND
E23	CHAN A REMOTE LEVEL.
E24	+28VDC
E25	REF.OSC.
E26	CHAN B REMOTE LEVEL

P2 PIN ASSIGNMENTS (SWITCH)

PIN #		E #	PIN #		E #
1	REF OSC		A	$\overline{Pa}$	
2	$\overline{REMOTE}$		B	$\overline{P_1}$	
3	$\overline{CK}$		C	$\overline{A/B}$	
4	$\overline{GATE}$	E18	D	$\overline{To}$	
5	$\overline{Fa}$		E	$\overline{TIA}$	
6	$\overline{10^9 + 100S}$		F	$\overline{TI}$	
7	$\overline{10^8 + 10S}$		H	D1C	
8	$\overline{10^7 + 1S}$		J	D10	
9	$\overline{10^6 + 100mS}$		K	D1A	
10	$\overline{10^5 + 10mS}$		L	D1B	
11	$\overline{10^4 + 1mS}$		M	Fa/10	
12	$\overline{10^3 + 100\mu S}$		N	UPDATE	
13	$\overline{10^2 + 10\mu S}$		P	$\overline{F_2}$ CLEAR	
14	$\overline{10 + 1\mu S}$		R	$\overline{REMOTE\ HOLD}$	
15	$\overline{T}$		S	PRINT	
16	$\overline{T'}$		T	ARM	
17	$\overline{EXT\ GATE}$		U	$\overline{REMOTE\ RESET}$	
18	———		V	$\overline{F_c}$	
19	+18VDC		W	−18VDC	
20	+28VDC		X	+5VDC ———	E9
21	GND. —E11-E14,E16,E17		Y	GND. —E11-E14,E16,E17	
22	———		Z	MARKER OUT	E15
23	———		AA	REF OUT	E19
24	———		BB	———	E20
25	EXT REF IN	E10	CC	f/n (SCALED OUT)	E21

P4 PIN ASSIGNMENTS (READOUT)

PIN #		E #	PIN #		E #
1	$\overline{PA}$		A	TCXO (REF OSC)	
2	$\overline{P1}$		B	$\overline{REMOTE}$	
3	$\overline{A/B}$		C	$\overline{CK}$	
4	$\overline{To}$		D	$\overline{GATE}$	
5	$\overline{TIA}$		E	$\overline{Fa}$	
6	$\overline{TI}$		F	$\overline{10^9 + 100S}$	
7	D1C		H	$\overline{10^8 + 10S}$	
8	D10		J	$\overline{10^7 + 1S}$	
9	D1A		K	$\overline{10^6 + 100mS}$	
10	D1B		L	$\overline{10^5 + 10mS}$	
11	Fa/10		M	$\overline{10^4 + 1mS}$	
12	UPDATE		N	$\overline{10^3 + 100\mu S}$	
13	$\overline{F_2}$ CLEAR		P	$\overline{10^2 + 10\mu S}$	
14	———		R	$\overline{10 + 1\mu S}$	
15	———		S	$\overline{T}$	
16	$\overline{T'}$		T	$\overline{REMOTE\ HOLD}$	
17	EXT GATE		U	PRINT	
18	$\overline{Fc}$		V	REMOTE RESET	
19	−18V		W	+18V	
20	+5V	E9	X	+28V	
21	GROUND	E11-E14,E16,E17	Y	Q102	E11-E14,E16,E17
22	Q101	E1	Z	Q101	E5
23	Q103	E2	AA	Q101	E6
24	Q103	E3	BB	Q102	E7
25	Q103	E4	CC	Q102	E8

J10 PIN ASSIGNMENTS (R-F BOARD)

PIN #	
A	———
B	$\overline{Fc}$
C	———
D	+5V
E	−18V
F	+18V

J9 PIN ASSIGNMENTS (SIGNAL COND)

PIN #	
1	REMOTE LEVEL 'A'
2	REMOTE LEVEL 'B'
3	GND
4	$\overline{REMOTE}$
5	−18V
6	+18V

NOTES. UNLESS OTHERWISE SPECIFIED

406580	7900	1	1
406527	8000	1	1
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0° 30'	+ .004
XX .020	FORMED	− .001
XXX .010	1° 0'	

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL | FINISH

DRAWN	AUSMAN	2-2-71
CHECK		2-7-71
DESIGN		2-10-71
MECH ENGR		
PROJ ENGR		4-7-71
PROD ENGR		4/7/71

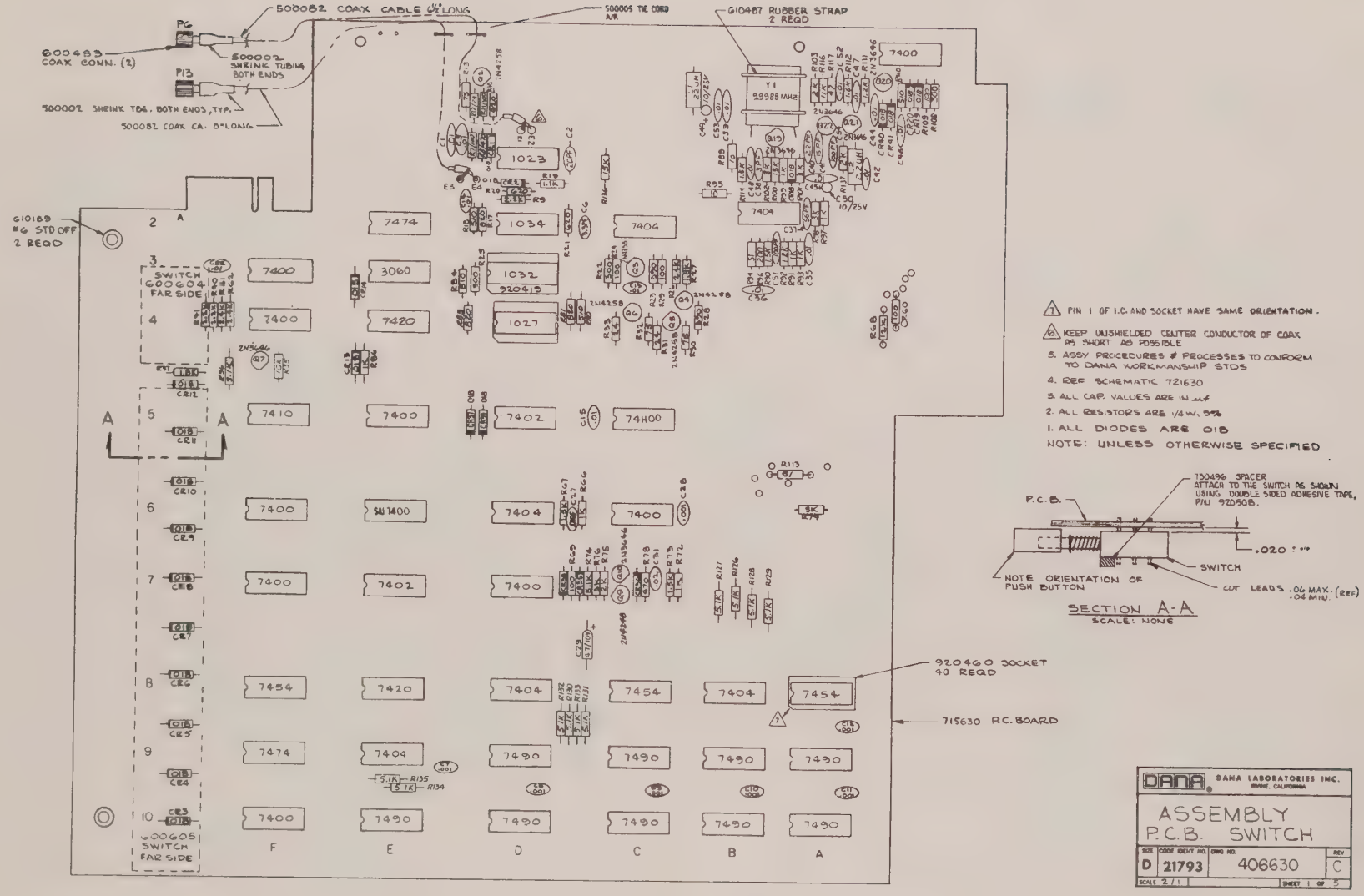
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

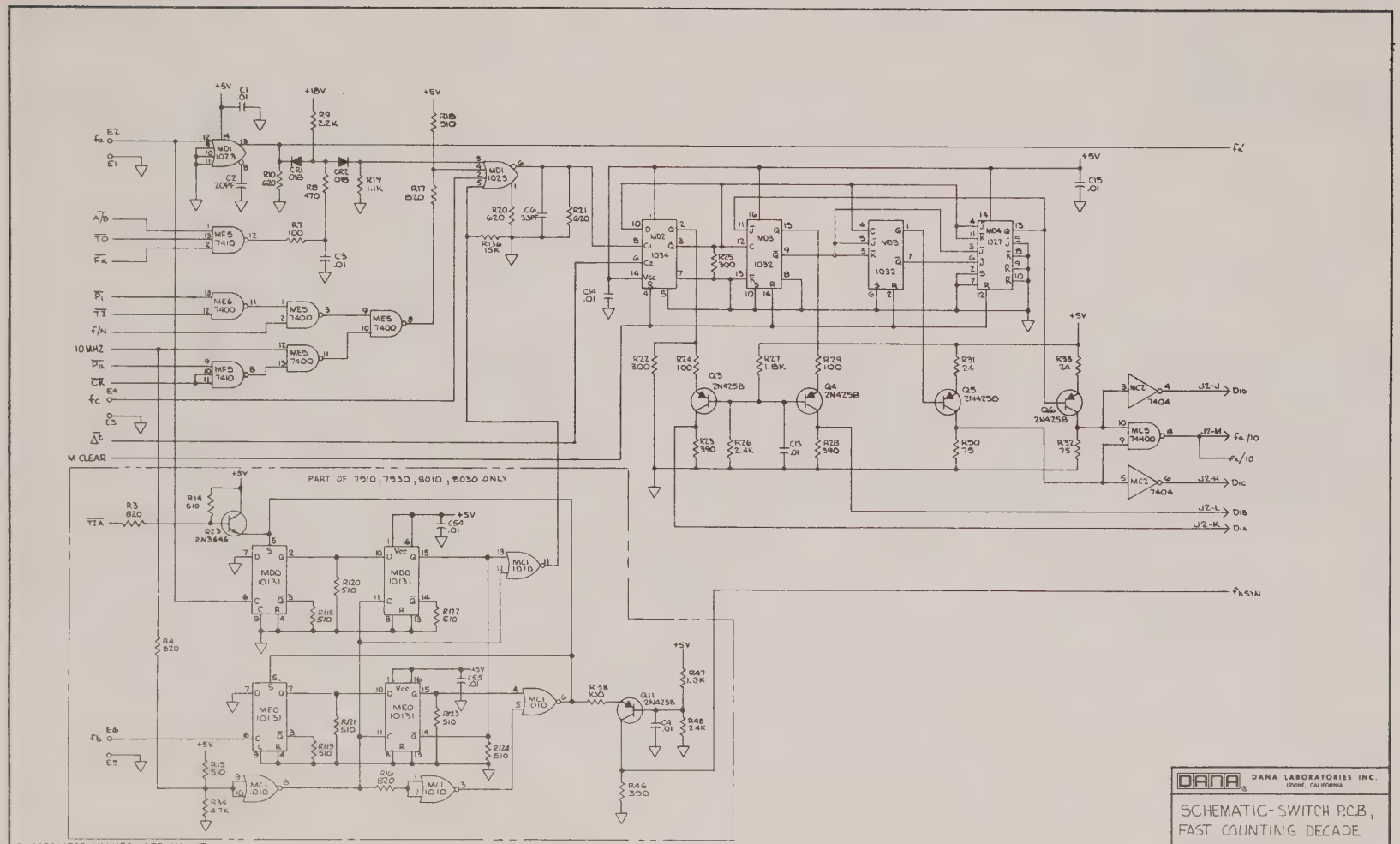
P.C.B. ASSY - INTERCONNECT

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	406128	A

SCALE 1/1 SHEET 1 OF 2

SHT 2 - A SIZE


500082 COAX CABLE 6½" LONG
500005 TIE CORD A/R
G10487 RUBBER STRAP 2 REQD
600483 COAX CONN. (2)
P6
P13
500002 SHRINK TUBING BOTH ENDS
500002 SHRINK TBG. BOTH ENDS, TYP.
500082 COAX CA. 6" LONG
G10189 #6 STD OFF 2 REQD
SWITCH 600604 FAR SIDE
600605 SWITCH FAR SIDE
Y1 99988 MHz
1023
1034
1032
920413
1027
7474
7404
7400
3060
7420
7410
7402
74H00
7454
7490
920460 SOCKET 40 REQD
715630 P.C. BOARD
1. ALL DIODES ARE 018
NOTE: UNLESS OTHERWISE SPECIFIED
2. ALL RESISTORS ARE 1/8 W, 5%
3. ALL CAP. VALUES ARE IN μf
4. REF SCHEMATIC 721630
5. ASSY PROCEDURES & PROCESSES TO CONFORM TO DANA WORKMANSHIP STDS
6. KEEP UNSHIELDED CENTER CONDUCTOR OF COAX AS SHORT AS POSSIBLE
7. PIN 1 OF I.C. AND SOCKET HAVE SAME ORIENTATION.
730496 SPACER ATTACH TO THE SWITCH AS SHOWN USING DOUBLE SIDED ADHESIVE TAPE, P/N 920508.
P.C.B.
.020 ± .010
SWITCH
NOTE ORIENTATION OF PUSH BUTTON
CUT LEADS .06 MAX. .04 MIN. (REF)
SECTION A-A
SCALE: NONE
DANA LABORATORIES INC. IRVINE, CALIFORNIA
ASSEMBLY P.C.B. SWITCH
SIZE D
CODE IDENT NO. 21793
DWG NO. 406630
REV C
SCALE 2/1
SHEET 1 OF 5



2. CAPACITOR VALUES ARE IN UF.

1. RESISTOR VALUES ARE IN OHMS ±5%, 1/4W.

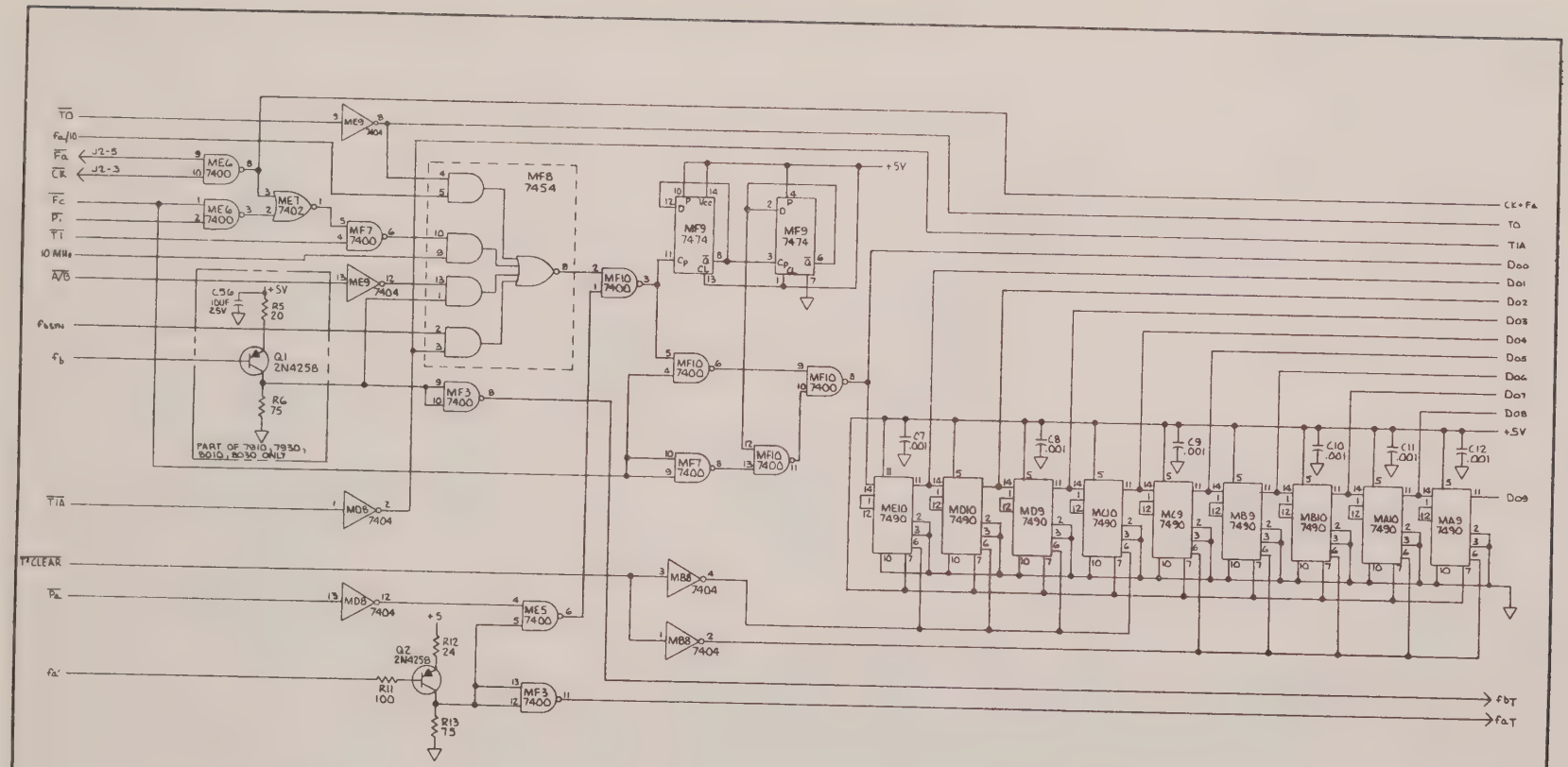
NOTES UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

SCHEMATIC-SWITCH P.C.B., FAST COUNTING DECADE

SIZE	CODE IDENT NO.	DWG NO	REV
D	21793	721630	A

SCALE — SHEET 1 OF 6



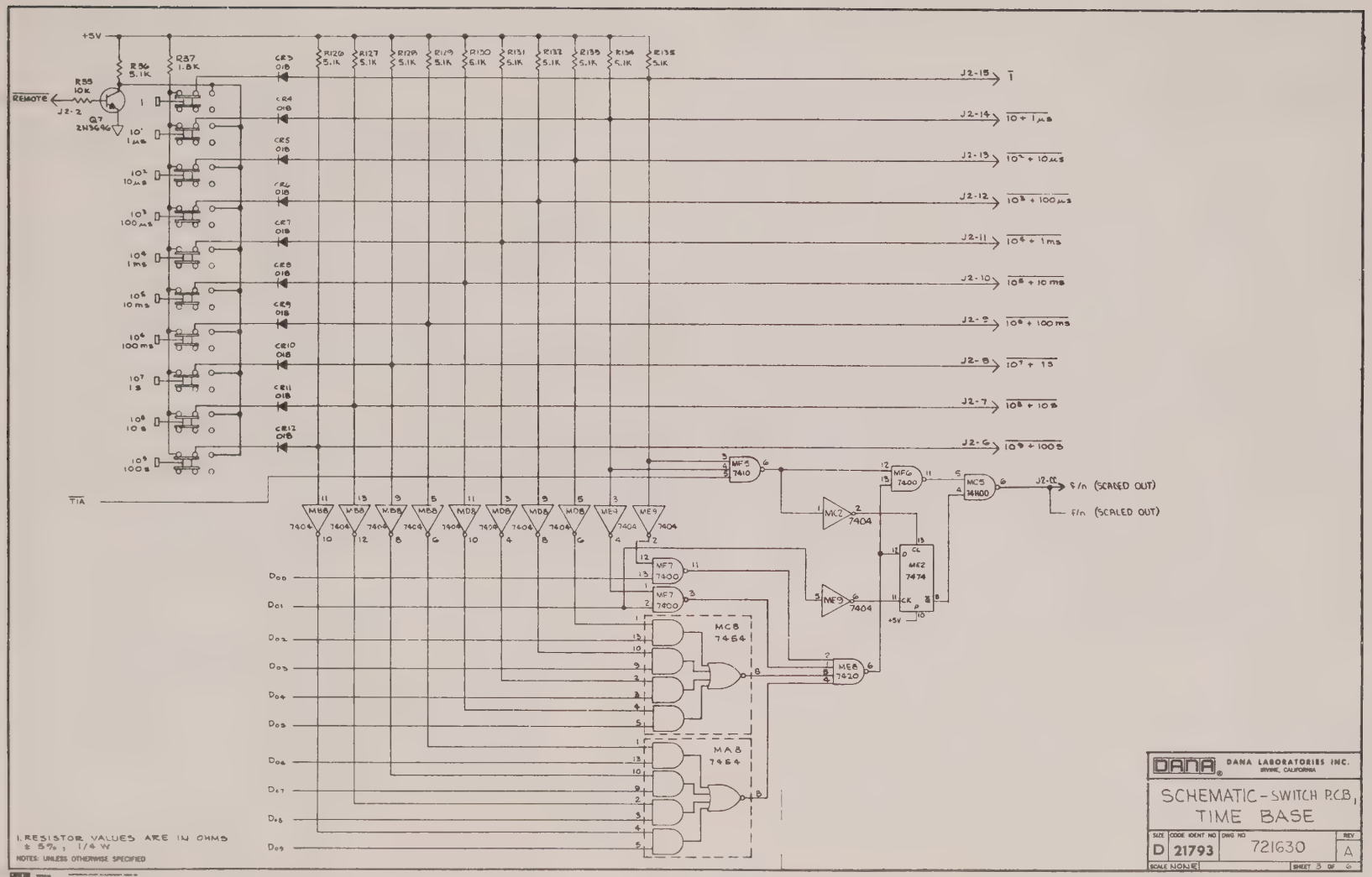
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC- TIME BASE DECADES

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	721630	A

SCALE — SHEET 2 OF 4



1. RESISTOR VALUES ARE IN OHMS ± 5%, 1/4 W

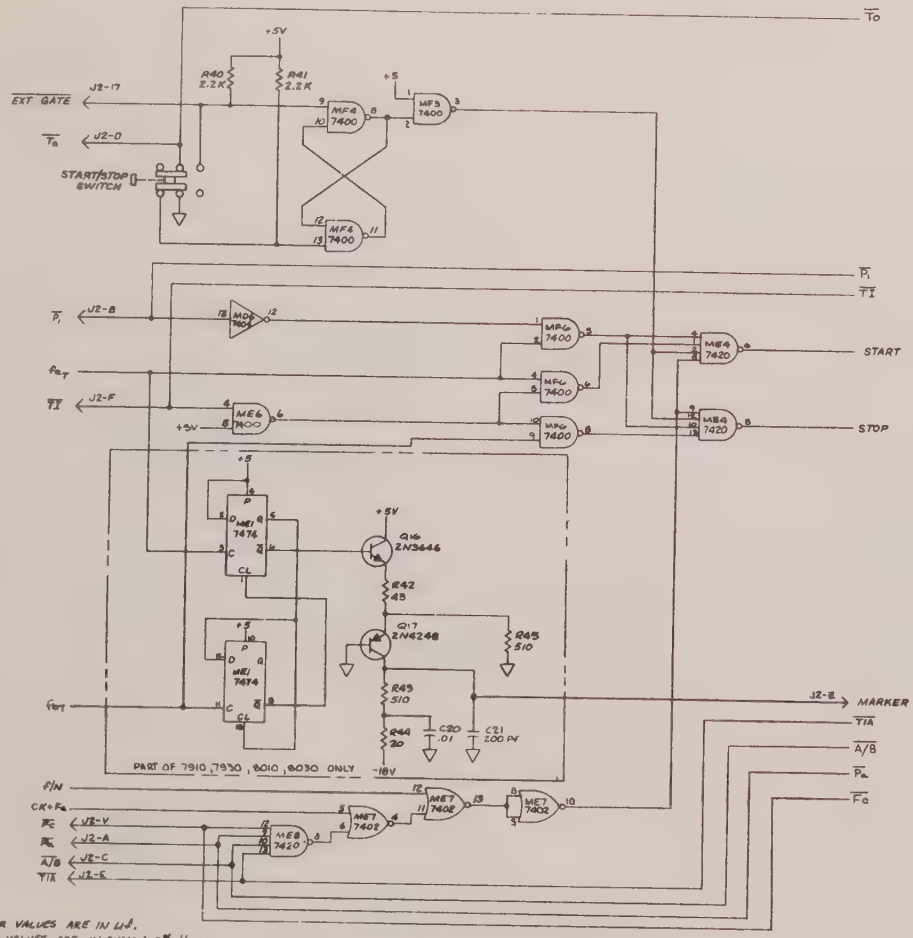
NOTES: UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

SCHEMATIC - SWITCH P.C.B., TIME BASE

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	721630	A

SCALE NONE SHEET 3 OF 6

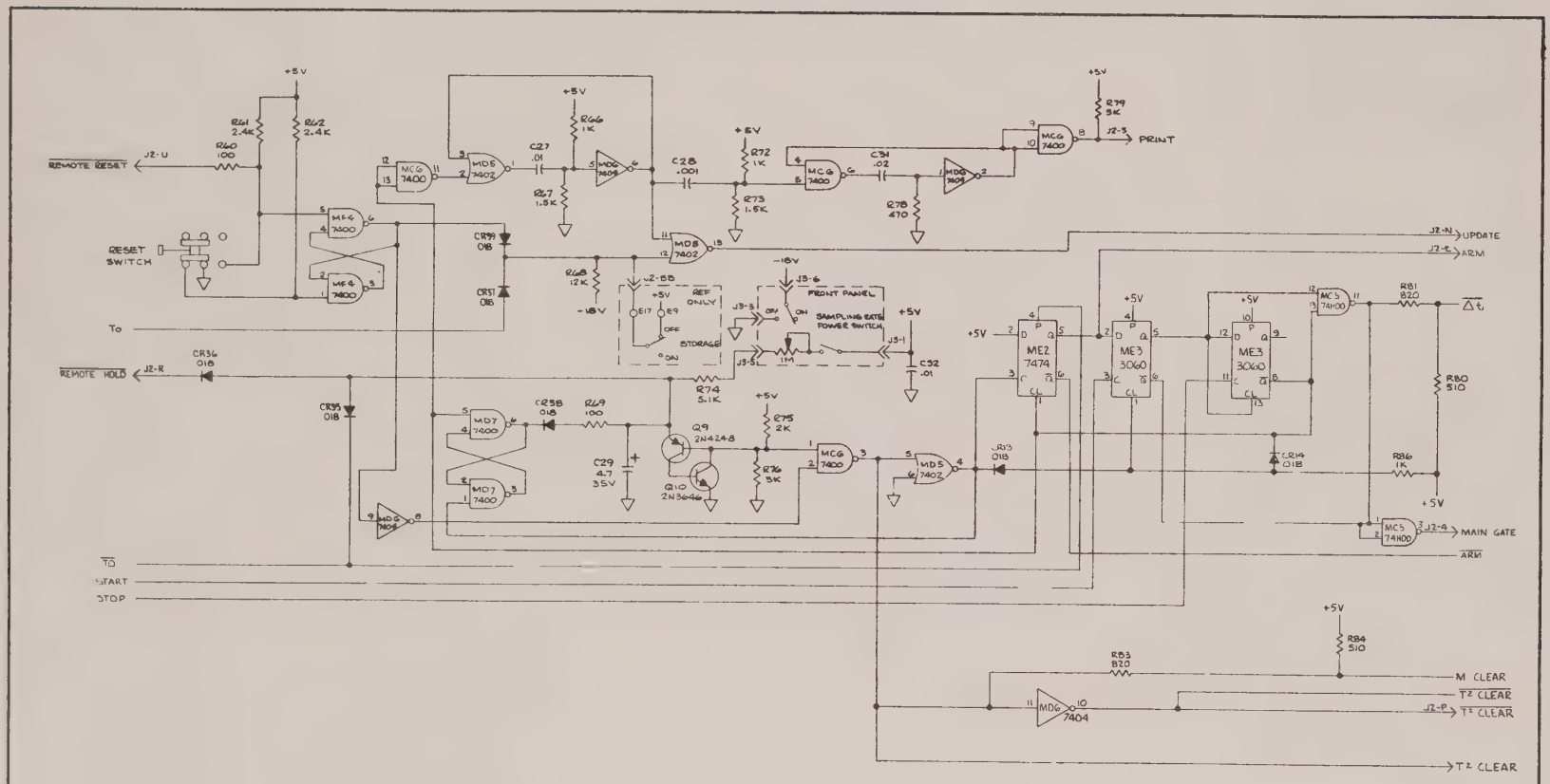


DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

SCHEMATIC – SWITCH P.C.B. START/STOP

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	721630	A

SCALE NONE SHEET 4 OF 6



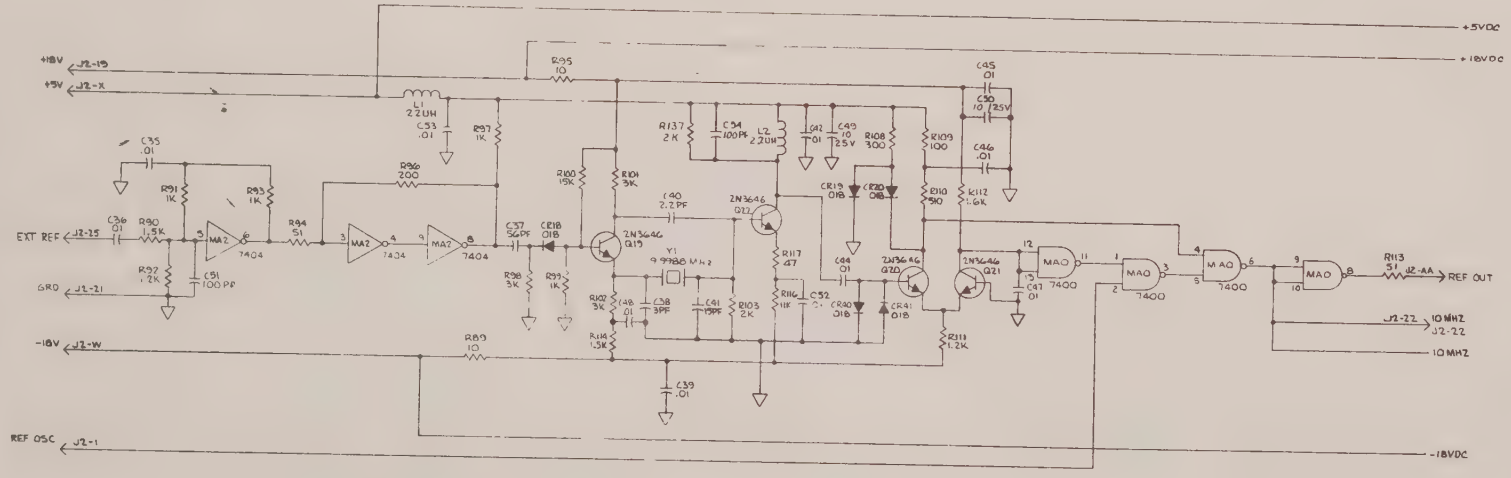
2. CAPACITOR VALUES ARE IN μf
1 RESISTOR VALUES ARE IN OHMS ±5%, 1/4W
NOTES: UNLESS OTHERWISE SPECIFIED

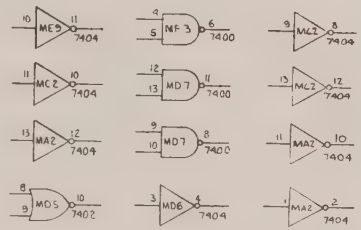
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – SWITCH P.C.B., EXECUTIVE LOGIC

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	721630	A

SCALE | SHEET 5 OF 6





NOT USED

1. LAST REF DESIGNATORS USED: R137, C54, CR41, Q22, L2 & Y1

NOTES: UNLESS OTHERWISE SPECIFIED

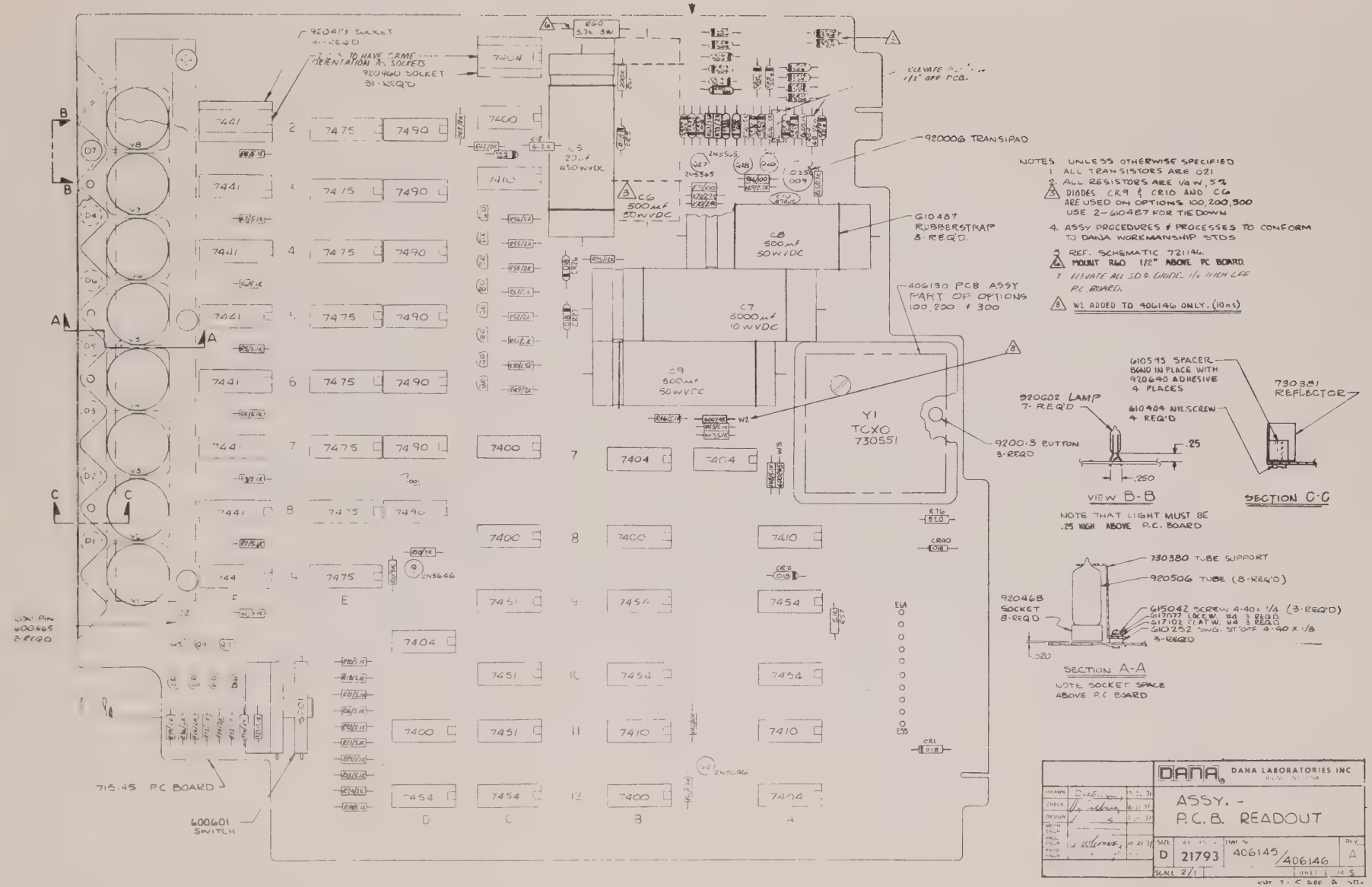
DANA LABORATORIES INC. IRVINE, CALIFORNIA

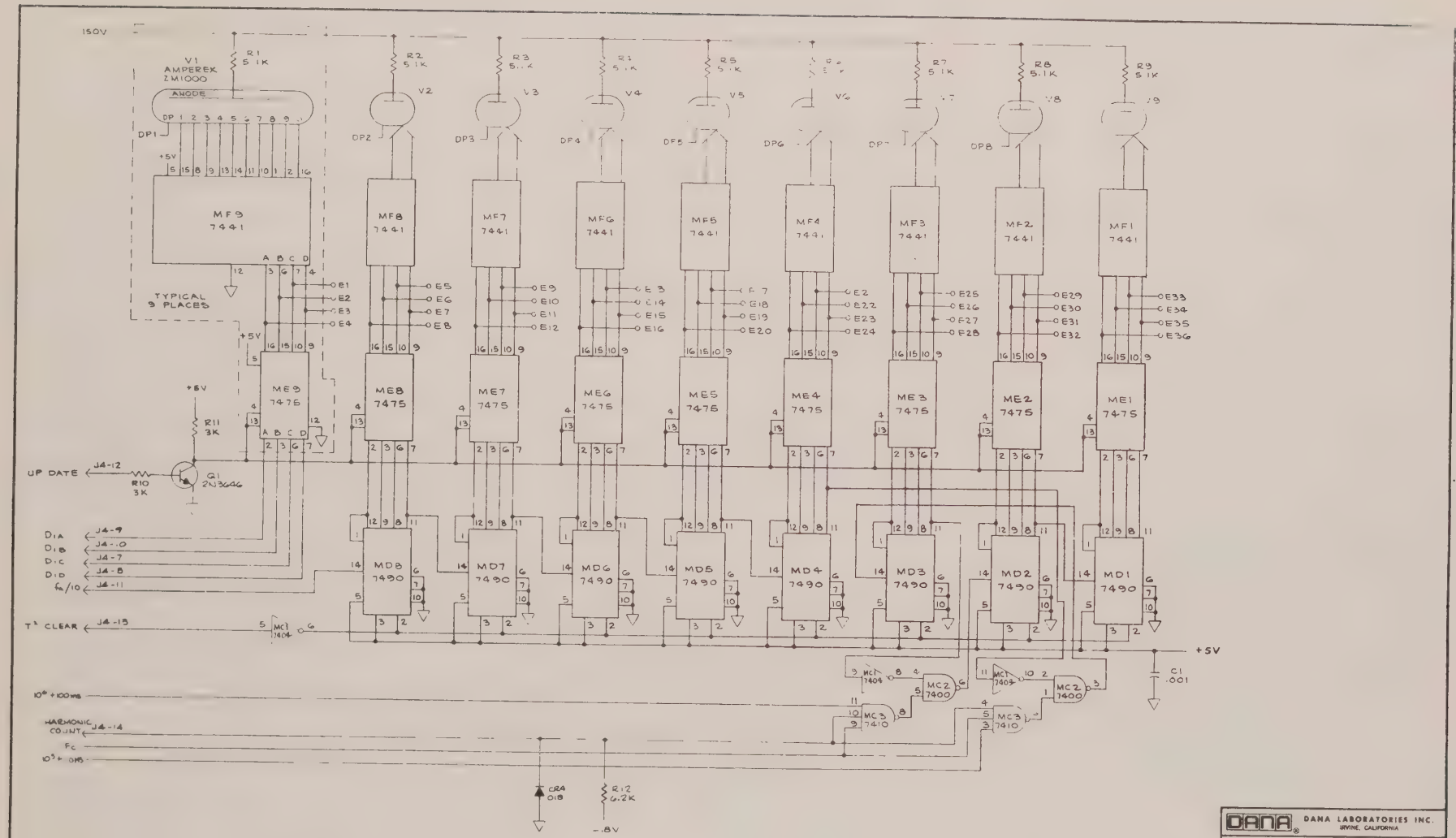
SCHEMATIC-SWITCH P.C.B. INT/EXT REFERENCE CIRCUIT

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	721630	A

SCALE

SHEET 6 OF 6


920413 SOCKET 16 REQ'D
920460 SOCKET 31 REQ'D
920006 TRANSIPAD
G10487 RUBBERSTRAP 8 REQ'D.
406130 PCB ASSY PART OF OPTIONS 100, 200 & 300
Y1 TCXO 730551
C3 20 mf 450WVDC
C6 500 mf 50WVDC
C8 500 mf 50WVDC
C7 5000 mf 10 WVDC
C9 500 mf 50WVDC
610595 SPACER BAND IN PLACE WITH 920640 ADHESIVE 4 PLACES
920602 LAMP 7 REQ'D
610404 NYL SCREW 4 REQ'D
730381 REFLECTOR
920018 BUTTON 8 REQ'D
.25
.250
VIEW B-B
SECTION C-C
NOTE THAT LIGHT MUST BE .25 HIGH ABOVE P.C. BOARD
730380 TUBE SUPPORT
920506 TUBE (8 REQ'D)
920468 SOCKET 8 REQ'D
615042 SCREW 4-40 x 1/4 (3 REQ'D)
617102 LOCKW. #4 3 REQ'D
617072 FLAT W. #4 3 REQ'D
610252 SWG. ST'OFF 4-40 X 1/8 3 REQ'D
.020
SECTION A-A
NOTE SOCKET SPACE ABOVE P.C BOARD
NOTES UNLESS OTHERWISE SPECIFIED
1 ALL TRANSISTORS ARE 021
2. ALL RESISTORS ARE 1/4 W, 5%
3 DIODES CR9 & CR10 AND C6 ARE USED ON OPTIONS 100, 200, 300 USE 2-610487 FOR TIE DOWN
4. ASSY PROCEDURES & PROCESSES TO CONFORM TO DANA WORKMANSHIP STDS
5 REF. SCHEMATIC 721146.
6 MOUNT R60 1/2" ABOVE PC BOARD.
7 ELEVATE ALL SOG DIODES 1/8 INCH OFF P.C. BOARD.
8 W1 ADDED TO 406146 ONLY. (10 ns)
713145 P.C. BOARD
600601 SWITCH
SIX PIN 600665 2 REQ'D
DANA LABORATORIES INC
ASSY. - P.C.B. READOUT
SIZE D
21793
DWG NO. 406145/406146
REV A
SCALE 2/1
SHEET 1 OF 5



2. ALL CAPACITOR VALUES ARE IN μf

1. ALL RESISTOR VALUES ARE IN OHMS, ±5%, 1/4 WATT

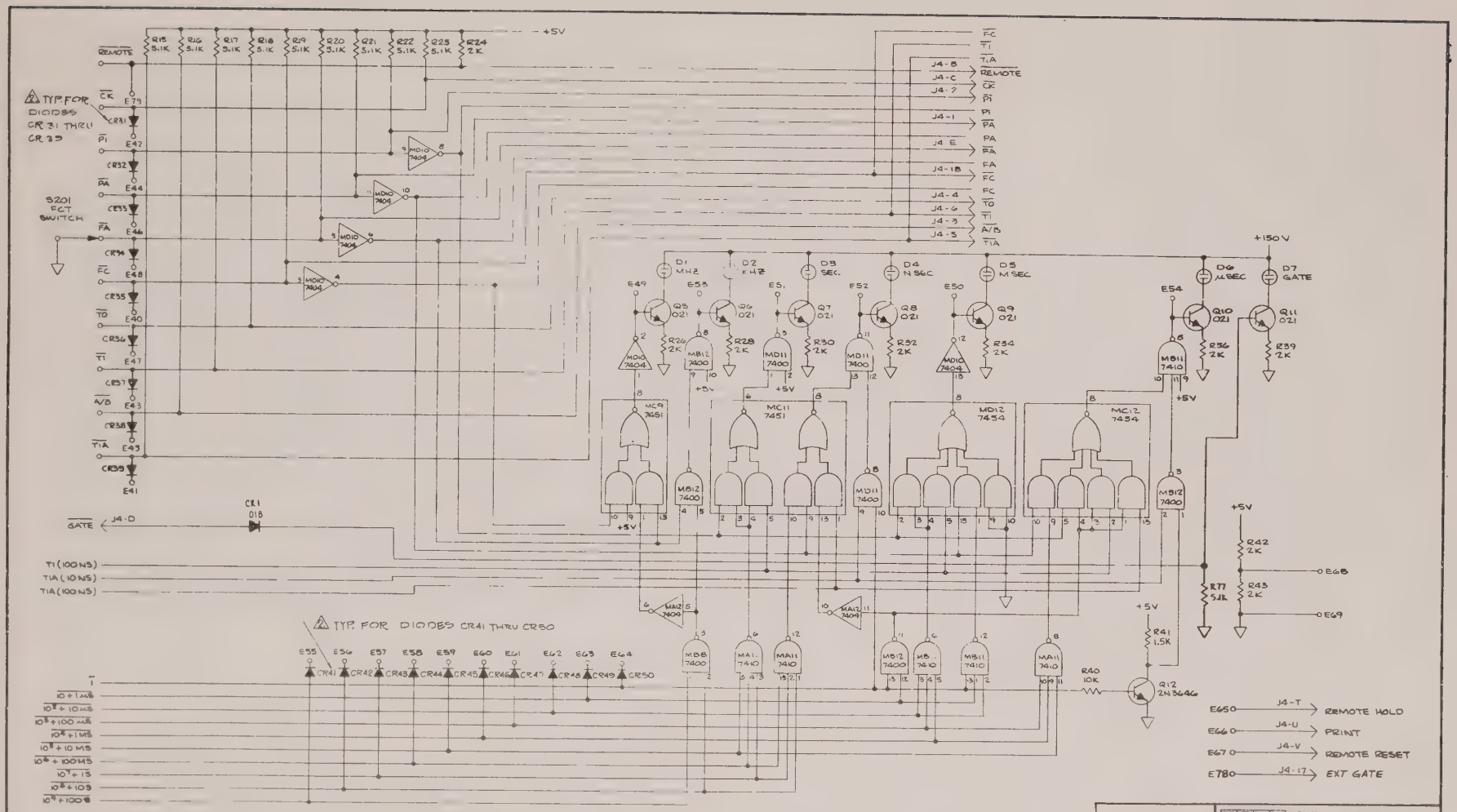
NOTES UNLESS OTHERWISE SPECIFIED

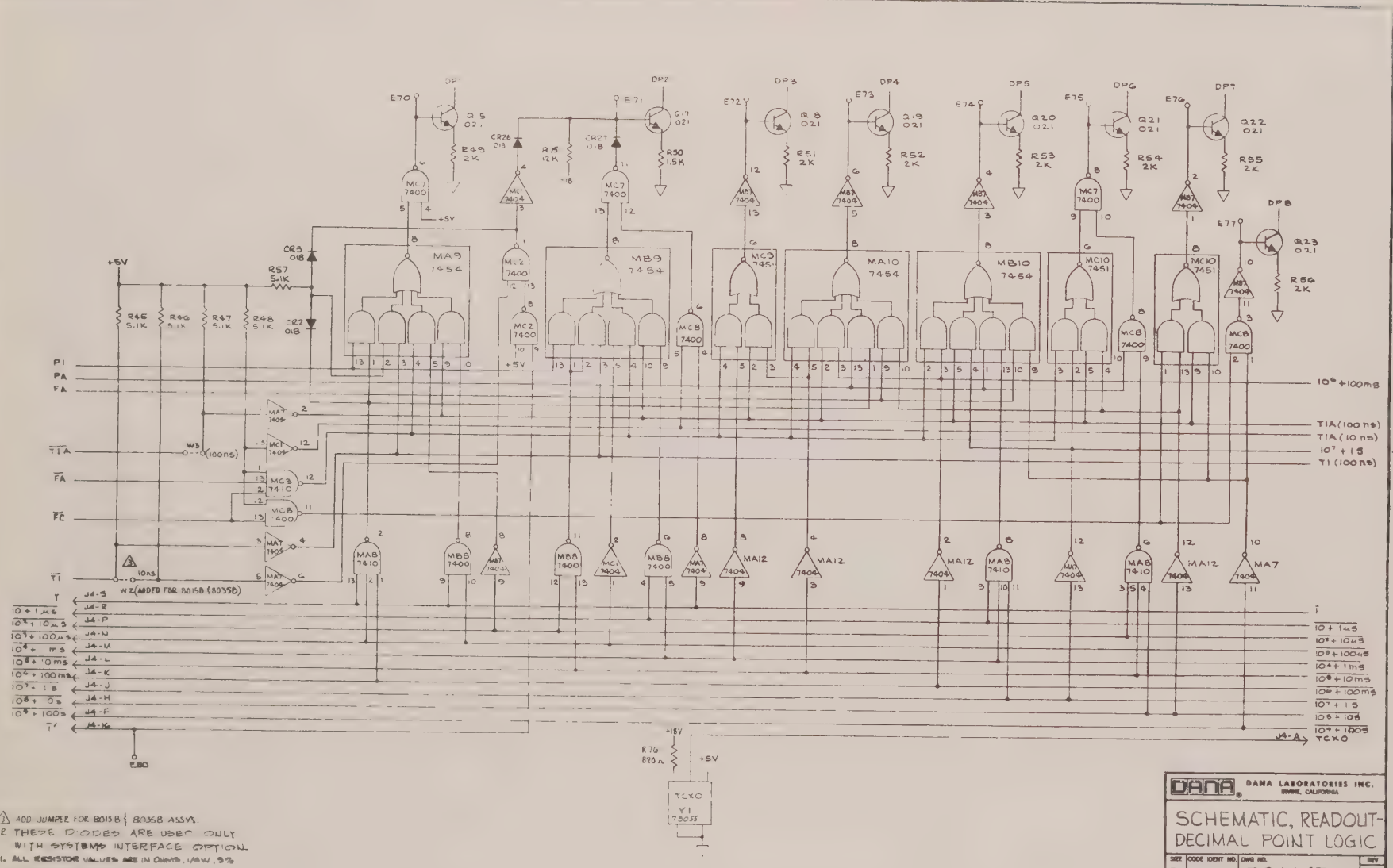
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC, READOUT-READOUT NETWORK

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	721145	A

SCALE NONE | SHEET 1 OF 4


+5V
REMOTE
TYP FOR DIODES CR31 THRU CR39
S201 FCT SWITCH
GATE
J4-D
CR1
D1B
TI (100 NS)
TIA (10 NS)
TIA (100 NS)
TYP FOR DIODES CR41 THRU CR50
+150 V
D1 MHZ
D2 KHZ
D3 SEC.
D4 N SEC
D5 M SEC
D6 μ SEC
D7 GATE
REMOTE HOLD
PRINT
REMOTE RESET
EXT GATE
THESE DIODES ARE USED ONLY WITH SYSTEMS INTERFACE OPTION.
ALL RESISTOR VALUES ARE IN OHMS, 1/4 W, 5%
NOTES: UNLESS OTHERWISE SPECIFIED
DANA LABORATORIES INC
IRVINE, CALIFORNIA
SCHEMATIC — READOUT UNITS LOGIC
SIZE D
CODE IDENT NO 21793
DWG NO 721145
-A
SHEET 4 OF 4



⚠ ADD JUMPER FOR B015B | B035B ASSY'S.
2. THESE DIODES ARE USED ONLY WITH SYSTEMS INTERFACE OPTION
1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%

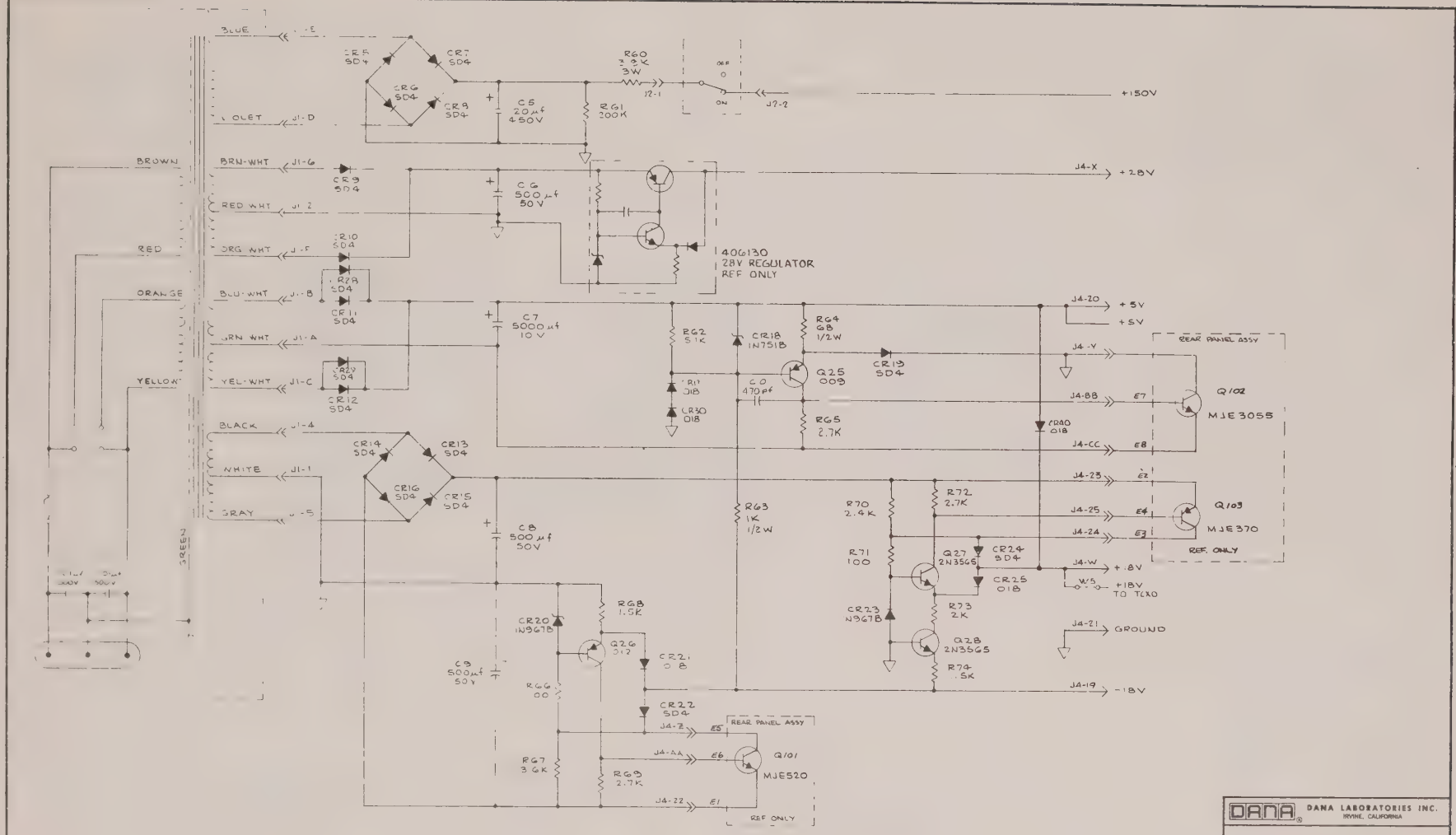
NOTES: UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC, READOUT-DECIMAL POINT LOGIC

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	721145	1A

SCALE NONE | SHEET 3 OF 4



ALL RESISTOR VALUES ARE IN OHMS 1/4W, 5%

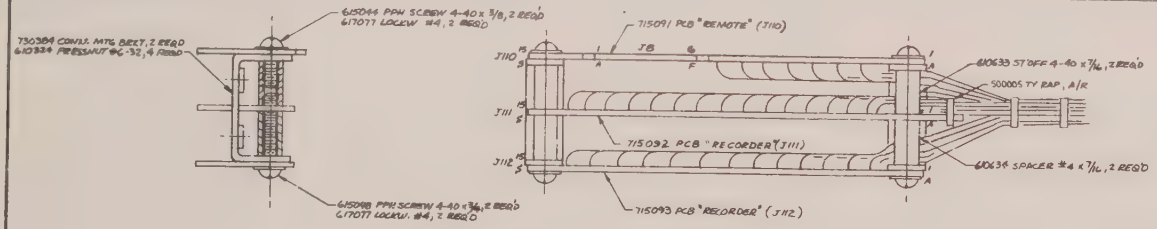
NOTES UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - READOUT - POWER SUPPLY

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	721145	A

SCALE NONE | SHEET 4 OF 4


730389 CONN'T. MTG BRKT, 2 REQ'D
610334 PRESSNUT #C-32, 4 REQ'D
615044 PPH SCREW 4-40 x 3/8, 2 REQ'D
617077 LOCKW. #4, 2 REQ'D
615098 PPH SCREW 4-40 x 3/16, 2 REQ'D
617077 LOCKW. #4, 2 REQ'D
715091 PCB "REMOTE" (J110)
J8
610633 STOFF 4-40 x 7/16, 2 REQ'D
500005 TY RAP, A/R
715092 PCB "RECORDER" (J111)
610634 SPACER #4 x 7/16, 2 REQ'D
715093 PCB "RECORDER" (J112)
J110
J111
J112

WIRING

ALL WIRES 24 GA, COATED

PCB 715091 REMOTE

		COLOR	FUNCTION	
J110 — A	E1	9-0	$\overline{ST}$	E40
B	E2	9-1	$\overline{STA}$	E41
C	E3	9-2	$\overline{STR}$	E42
D	E4	9-2-3	$\overline{MT}$	E43
E	E5	9-3-4	$\overline{ST}$	E44
F	E6	9-3-5	$\overline{STB}$	E45
H	E7	9-3-6	$\overline{STA}$	E46
J	E8	9-1-7	$\overline{STO}$	E47
K	E9	9-1-8	$\overline{STA}$	E48
L	E10	9-1-4	REMOTE	E79
M	J8-A			
N	J8-D			
P	J8-C			
R	J8-B			
S	J8-A			
1	E11	0	$\overline{T}$	E44
2	E12	1	$10^1 + 1$ HZ	E68
3	E13	2	$10^2 + 10$ HZ	E62
4	E14	3	$10^3 + 100$ HZ	E61
5	E15	4	$10^4 + 1$ KHZ	E60
6	E16	5	$10^5 + 10$ KHZ	E69
7	E17	6	$10^6 + 100$ KHZ	E68
8	E18	7	$10^7 + 1$ MHZ	E67
9	E19	8	$10^8 + 10$ MHZ	E54
10	E20	9-2-0	$10^9 + 100$ MHZ	E55
11	E21	9-2-1	REM HOLD	E63
12	E22	9-1-3	REM RESET	E49
13	E23	9-2-4	REM STATE	E70
14	E24	9-1-6	$\overline{T}$	E80
J110 — 15	J8-1			

READOUT PCB 715085 ⚠1

PCB 715092 RECORDER

		COLOR	FUNCTION	
J111 — A	E34	4	V1-4	E1
B	E35	B	V1-B	E3
C	E36	4	V2-4	E5
D	E37	B	V2-B	E7
E	E38	4	V3-4	E9
F	E39	B	V3-B	E11
N	E40	4	V4-4	E13
J	E41	B	V4-B	E15
K	E42	4	V5-4	E17
L	E43	B	V5-B	E19
M	E44	4	V6-4	E21
N	E45	B	V6-B	E23
P	E46	4	V7-4	E25
R	E47	B	V7-B	E27
S	E48	4	V8-4	E29
1	E49	1	V1-1	E4
2	E50	2	V1-2	E2
3	E51	1	V2-1	E8
4	E52	2	V2-2	E6
5	E53	1	V3-1	E12
6	E54	2	V3-2	E10
7	E55	1	V4-1	E16
8	E56	2	V4-2	E14
9	E57	1	V5-1	E20
10	E58	2	V5-2	E18
11	E59	1	V6-1	E24
12	E60	2	V6-2	E22
13	E61	1	V7-1	E28
14	E62	2	V7-2	E26
J111 — 15	E63	1	V8-1	E32

READOUT PCB 715085 ⚠1

PCB 715093 RECORDER

		COLOR	FUNCTION	
J112 — A	E26	B	V8-B	E31
B	E27	4	V9-4	E33
C	E28	B	V9-B	E35
D	E29	9-1-1	MHz	E49
E	E30	9-1-2	KHz	E53
F	E31	9-2-3	SEC	E51
H	E32	9-2-4	H SEC	E52
J	E33	9-1-5	M SEC	E50
K	E34	9-2-6	M SEC	E54
L	E35			
M	E36			
N	E37	N/C		
P	E38			
R	E39			
S	E40	1	PRINT	E66
1	E41	2	V8-2	E30
2	E42	1	V9-1	E34
3	E43	2	V9-2	E36
4	E44	9-1	DP1	E70
5	E45	9-2	DP2	E71
6	E46	9-2-3	DP3	E72
7	E47	9-3-4	DP4	E73
8	E48	9-3-5	DP5	E74
9	E49	9-3-6	DP6	E75
10	E50	9-1-7	DP7	E76
11	E51	9-1-8	DP8	E77
12	E52	N/C		
13	E53	N/C		
14	E54	0	ZERO REF	E69
J112 — 15	E55	1	ONE REF	E60

READOUT PCB 715085 ⚠1

2. HARNESS ROUTING DWG. IS SHEET 2 OF THIS DWG.

⚠1 WILL BE HARD WIRED NEXT ASSEMBLY.

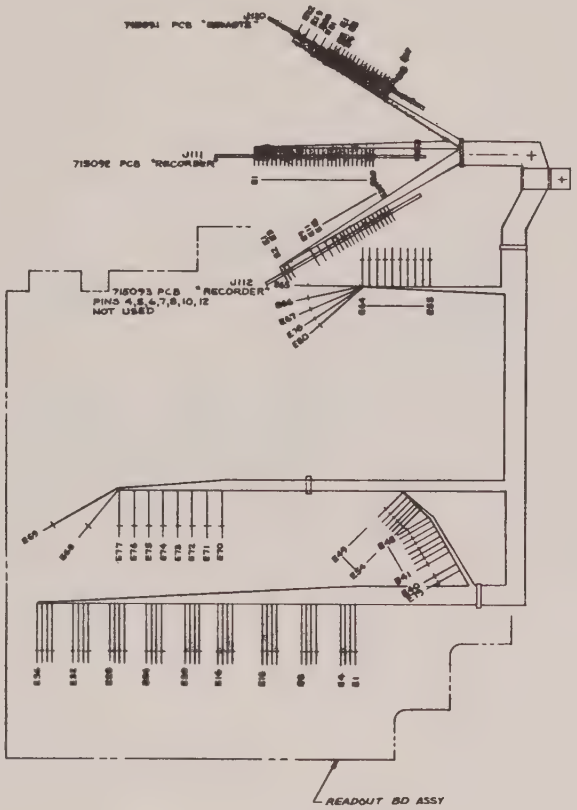
NOTES: UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY-HARNESS, REMOTE & RECORDER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	406563	F

SCALE 2/1 SHEET 1 OF 4



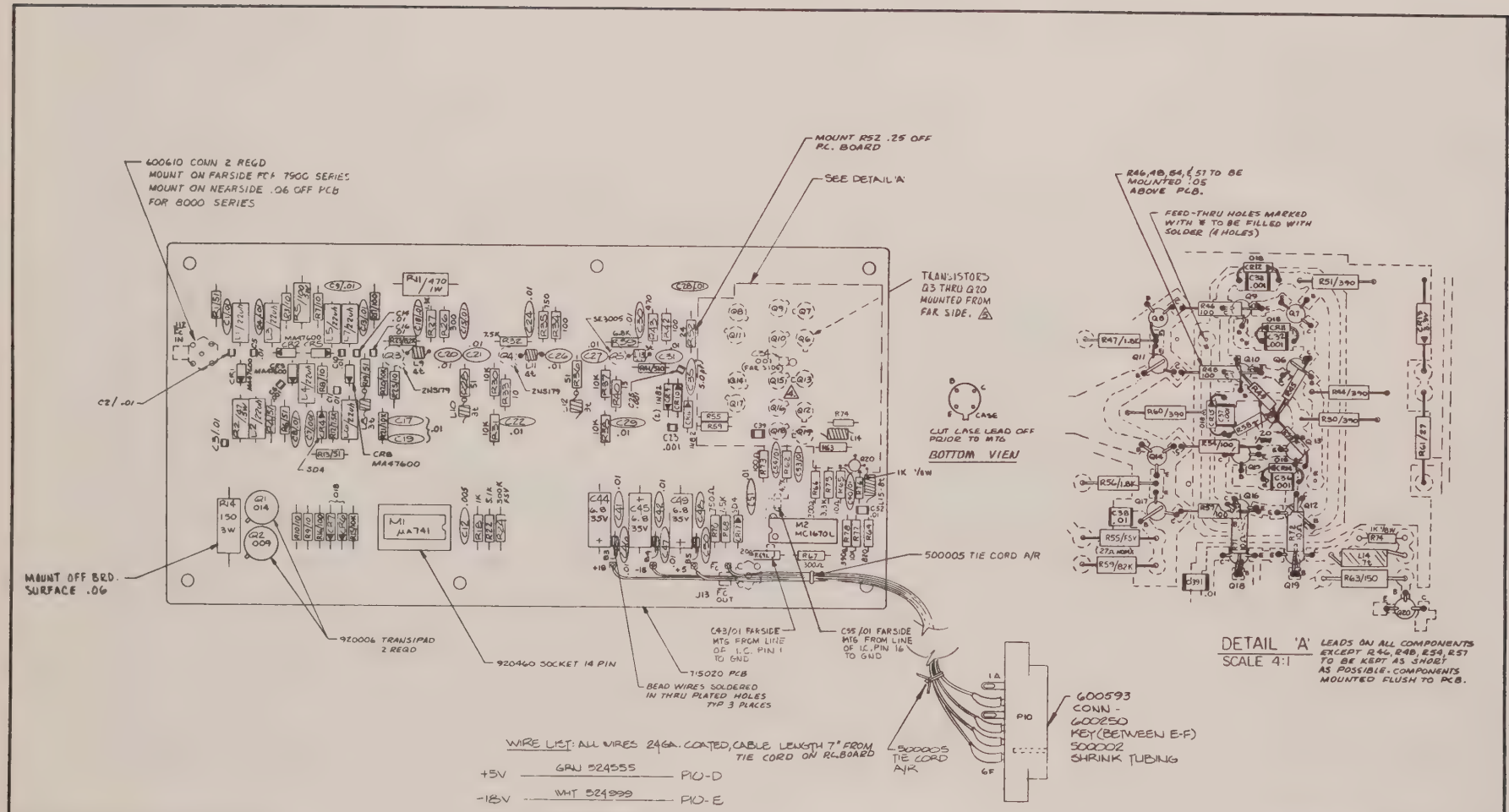
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY - HARNESS, REMOTE & RECORDER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	406563	F

SCALE 1/1 SHEET 1 OF 1


600610 CONN 2 REQD
MOUNT ON FARSIDE PCB 7900 SERIES
MOUNT ON NEARSIDE .06 OFF PCB
FOR 8000 SERIES
MOUNT RS2 .25 OFF P.C. BOARD
SEE DETAIL 'A'
TRANSISTORS Q3 THRU Q20 MOUNTED FROM FAR SIDE.
CUT CASE LEAD OFF PRIOR TO MTG
BOTTOM VIEW
CASE
C2/.01
C3/.01
MOUNT OFF BRD. SURFACE .06
920006 TRANSIPAD 2 REQD
920460 SOCKET 14 PIN
BEAD WIRES SOLDERED IN THRU PLATED HOLES TYP 3 PLACES
7150-20 PCB
C43/.01 FARSIDE MTG FROM LINE OF I.C. PIN 1 TO GND
C55/.01 FARSIDE MTG FROM LINE OF IC. PIN 16 TO GND
500005 TIE CORD A/R
J13 FC OUT
M1 MA741
M2 MC1670L
CR8 MA47600
1K ¼W
R46,48,54,& 57 TO BE MOUNTED .05 ABOVE PCB.
FEED-THRU HOLES MARKED WITH ✱ TO BE FILLED WITH SOLDER (4 HOLES)
DETAIL 'A'
SCALE 4:1
LEADS ON ALL COMPONENTS EXCEPT R46, R48, R54, R57 TO BE KEPT AS SHORT AS POSSIBLE. COMPONENTS MOUNTED FLUSH TO PCB.
600593 CONN - 600250 KEY (BETWEEN E-F) 500002 SHRINK TUBING
500005 TIE CORD A/R
P10
1A
6F

WIRE LIST: ALL WIRES 24GA. COATED, CABLE LENGTH 7" FROM TIE CORD ON P.C.BOARD

+5V	GRN 524555	P10-D
-18V	WHT 524999	P10-E
+18V	RED 524222	P10-F
FC	WHT-RED 524992	P10-B

⚠ Q6 & Q10, Q7 & Q9, Q8 & Q11, Q12 & Q16, Q14 & Q17, Q13 & Q15 ARE MATCHED PR. PER DANA P/N 200186

⚠ SOLDER TRANSISTOR CASE TABS OF Q6-Q20 TO GROUND PLANE.

3. ALL ASSEMBLIES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

2. ALL RESISTOR VALUES ARE IN OHMS ± 5% 1/4W.

1. SCHEMATIC REF 721120.

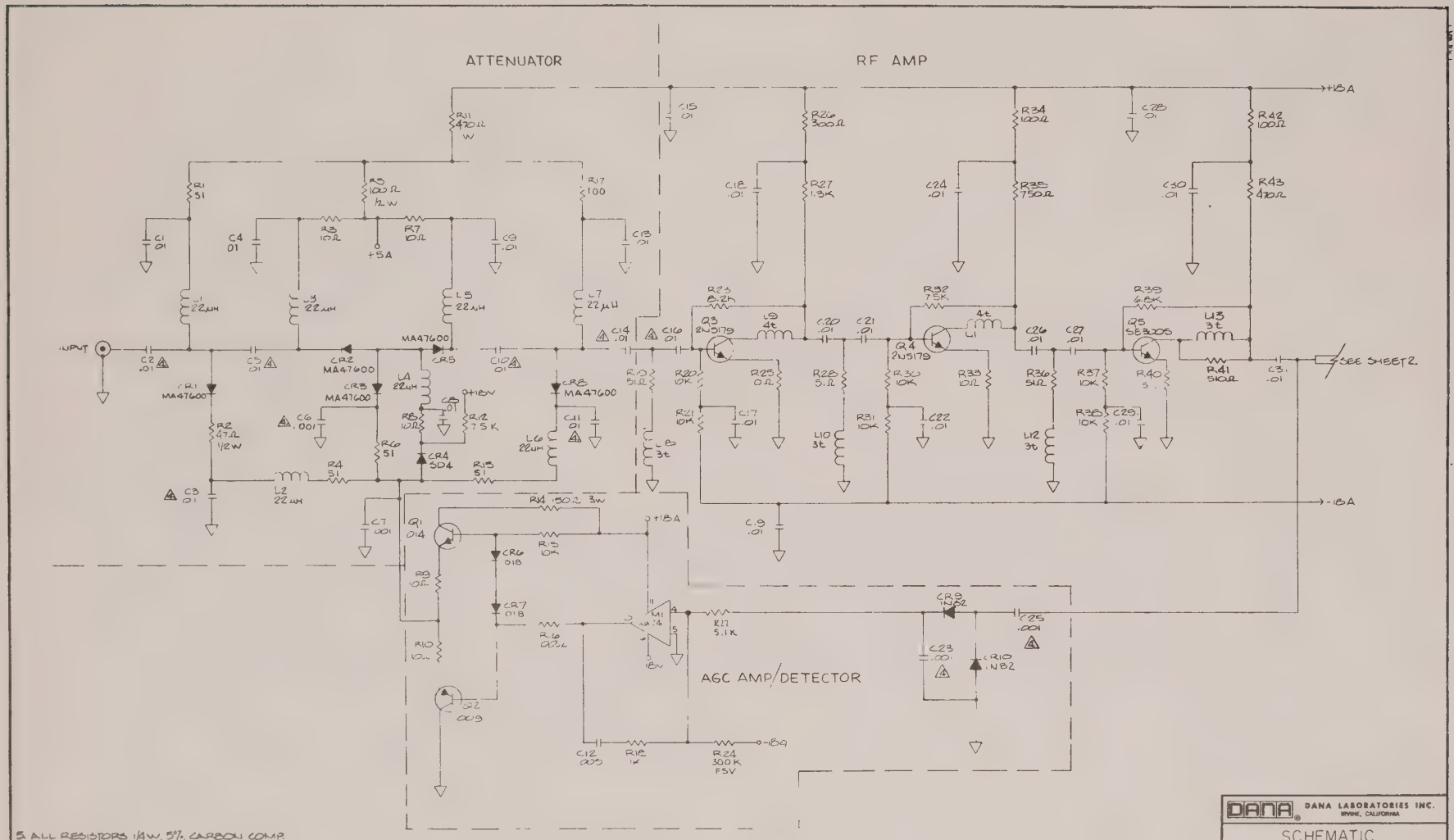
NOTES: UNLESS OTHERWISE SPECIFIED

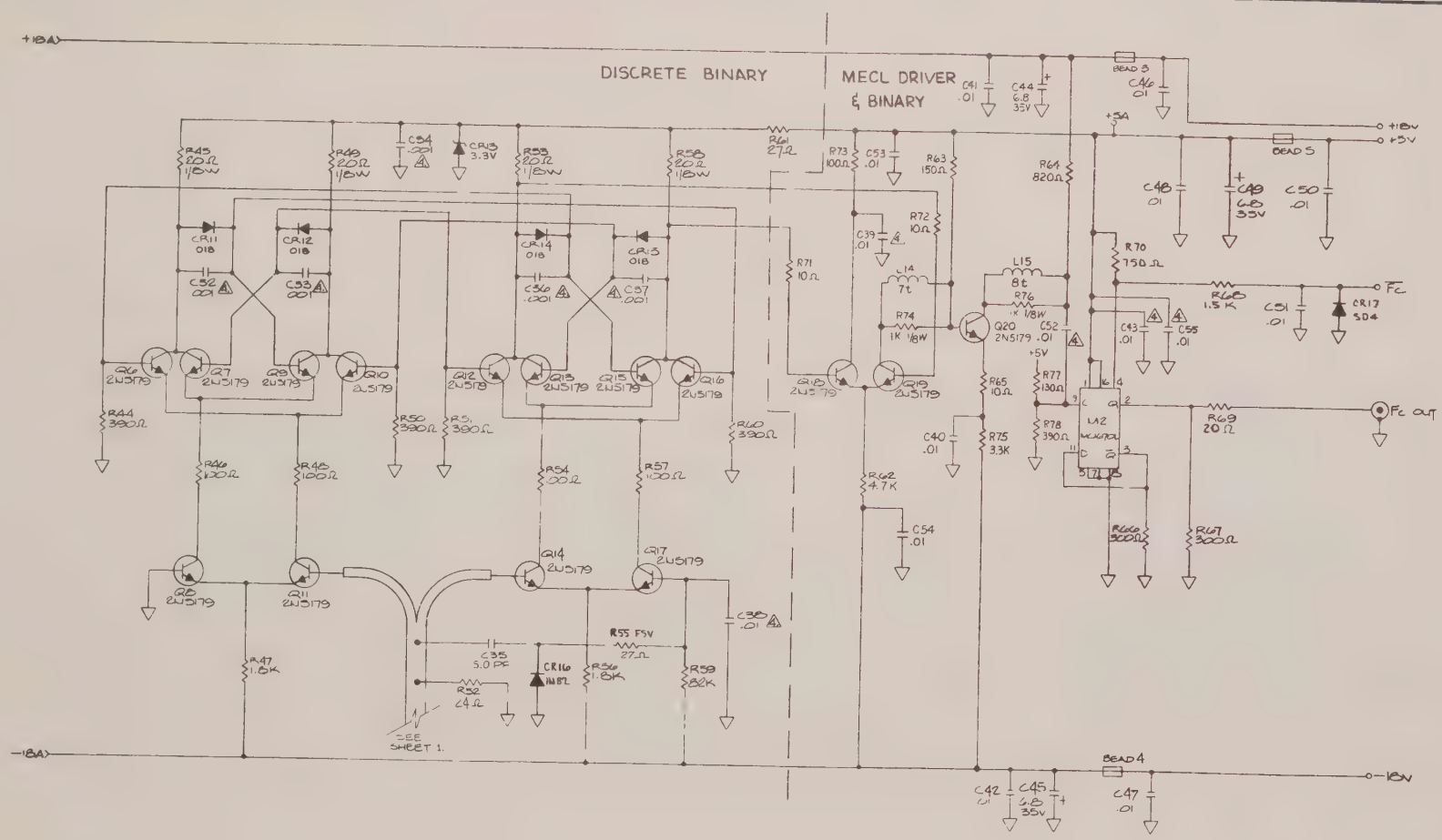
DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

PCB ASSY - 500 MHz PRESCALER (50 MV SENSITIVITY)

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	406120	E

SCALE 2/1 SHEET 1 OF 5


ATTENUATOR
RF AMP
AGC AMP/DETECTOR
INPUT
+18A
-18A
+18V
-18V
+5A
SEE SHEET 2.
MA47600
2N5179
SE3005
NOTES, UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS 1/4W, 5%, CARBON COMP.
2. CHIP CAPACITORS
3. ALL CAP VALUES ARE MFD.
4. ALL DIODES DIB.
5. LAST DESIGNATORS USED: R48, CR16, C51, Q20, L11, L14, & BEAD 4.
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC
500 MHZ
PRESCALER (50MV)
SIZE D
CODE IDENT NO 21793
DWG NO 721120
REV D
SCALE NONE
SHEET 1 OF 2



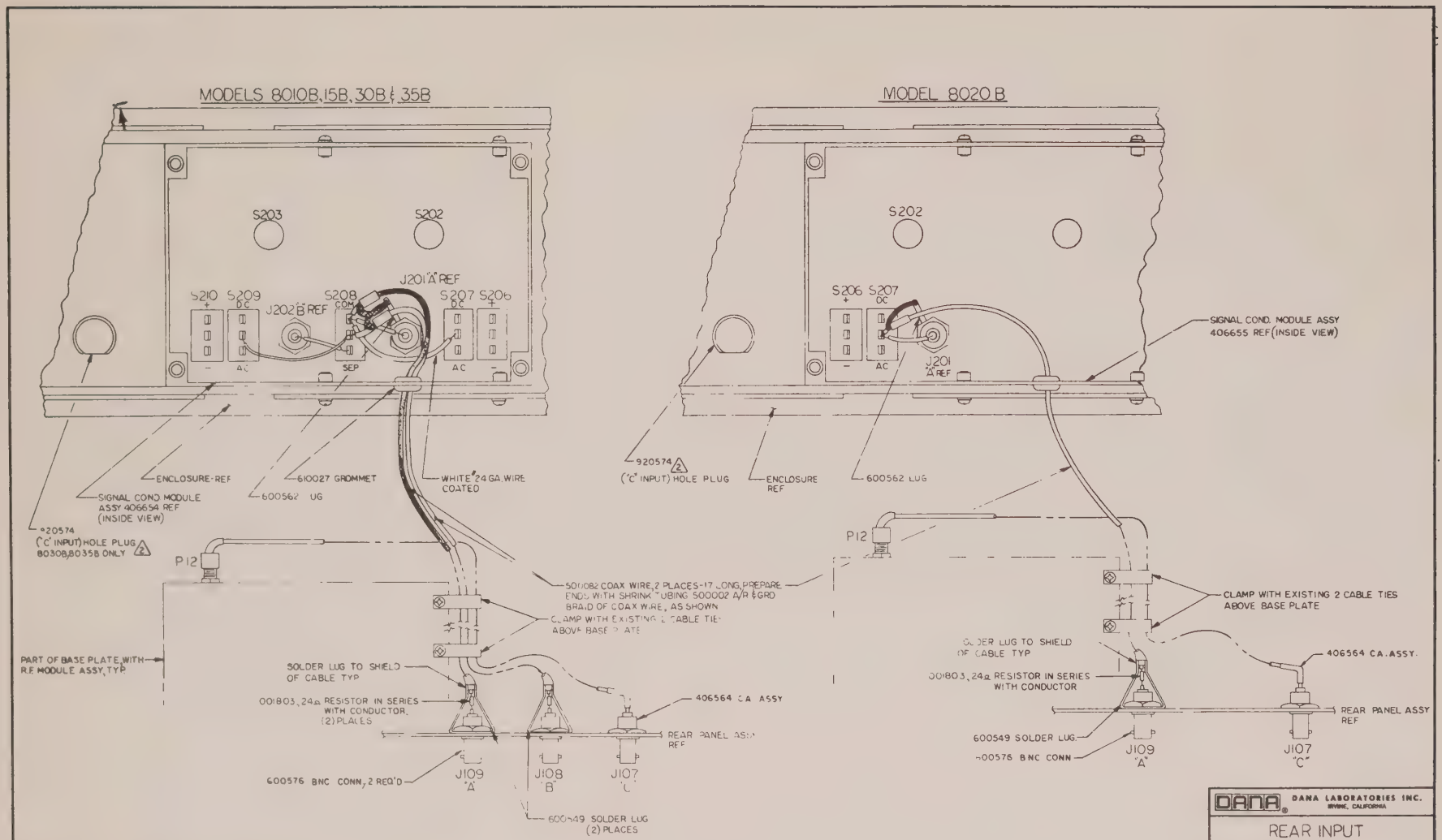
SEE SHEET 1.
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC
500 MHZ
PRESCALER (50MV)

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	721120	D

SCALE NONE | SHEET 2 OF 2



⚠2 RETURN 406520 CA ASSY TO STOCK

1 REF DESIGNATORS SHOWN FOR IDENTIFICATION PURPOSE ONLY

NOTES: UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

REAR INPUT -OPTION 010-

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	406660-662	A

SCALE 2/1 SHEET 1 OF 4

PARTS LIST

ASSEMBLY 406655 – MODULE, SIGNAL COND (SINGLE CHANNEL)

REF DES	PART NO.	DESCRIPTION						
B01	920563	BEADS					FERX CBE	56-59065-4B
C01	100063	CAP		.01 MFD	500 V	20%	SPRAGUE	5GAS-S10
C02	101182	CAP	CERAM	47 PFD	500 V	10%	AEROVOX	TCD-N750
C03	100009	CAP	CERAM	5 PFD	500 V	10%	AEROVOX	TCD-N750
C04	100012	CAP	CERAM	33 PFD	500 V	10%	AEROVOX	TCD-N750
C05	100009	CAP	CERAM	5 PFD	500 V	10%	AEROVOX	TCD-N750
C06	101182	CAP	CERAM	47 PFD	500 V	10%	AEROVOX	TCD-N750
J201	600567	CONN					AMPHENOL	31-236-1050
R01	010609	RES	METAL	909 K		1% T-0	ELECTRA	RN60D9093F
R02	010680	RES	METAL	90.9 K		1%	IRC	RN55C
R03	010529	RES		10 K		1%	IRC	RN55D
R04	000104	RES	CARBON	100 K		5% 1/4W	OHMITE	RC07GF104J
S202	600603	SWITCH	ATTENUATOR				CTS	
S206	600613	SWITCH	SLIDE SPDT		WITH .328 KNOB		CW	GF-124
S207	600613	SWITCH	SLIDE SPDT		WITH .328 KNOB		CW	GF-124

PARTS LIST

ASSEMBLY 406148 – SIGNAL COND (SINGLE CHANNEL)

REF DES	PART NO.	DESCRIPTION						
B01	920563	BEADS					FERX CBE	56-59065-4B
B02	920563	BEADS					FERX CBE	56-59065-4B
B03	920563	BEADS					FERX CBE	56-59065-4B
C01	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C02	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C03	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C04	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C06	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C07	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C08	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C09	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C10	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C11	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C12	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
CR01	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		MOTOROLA	1/4M3.3AZ5
CR02	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		MOTOROLA	1/4M3.3AZ5
CR03	211236	DIODE	SILICO		007		DANA	211236
CR04	211236	DIODE	SILICO		007		DANA	211236
CR05	220019	DIODE	SILICO	ZENER	1N752A		MOTOROLA	1N752A
CR06	211083	DIODE	SILICO		018		DANA	211083
CR07	211083	DIODE	SILICO		018		DANA	211083
CR08	211083	DIODE	SILICO		018		DANA	211083
CR08	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
J07	600573	CONN					SELECTRO	50-051-0000
L01	310068	CHOKE		1 UH			DELEVAN	1537-12
L02	310068	CHOKE		1 UH			DELEVAN	1537-12
L03	310101	CHOKE	RF	.27 UH			DELEVAN	1025-06
L04	310101	CHOKE	RF	.27 UH			DELEVAN	1025-06
P09	600593	CONN		6 PIN			CINCH	250-06-30-170
Q01	200189	TRANS	MATCHED PAIR				DANA	200189
Q02	200186	TRANS	MATCHED PAIR				DANA	200186
Q03	200151	TRANS					MOTOROLA	2N5179
Q04	200151	TRANS					MOTOROLA	2N5179
Q05	200151	TRANS					MOTOROLA	2N5179
Q06	200151	TRANS					MOTOROLA	2N5179

PARTS LIST

ASSEMBLY 406148 – SIGNAL COND (SINGLE CHANNEL)

REF DES	PART NO.	DESCRIPTION						
Q07	200151	TRANS					MOTOROLA	2N5179
Q08	200151	TRANS					MOTOROLA	2N5179
Q09	200186	TRANS	MATCHED PAIR				DANA	200186
Q10	200189	TRANS	MATCHED PAIR				DANA	200189
Q11	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q12	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q13	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
Q14	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
R01	000222	RES	CARBON	2.2 K		5% 1/4W	OHMITE	RC07GF222J
R02	000222	RES	CARBON	2.2 K		5% 1/4W	OHMITE	RC07GF222J
R03	010720	RES	METAL	9.09 K		.25%	IRC	RN55C
R04	000102	RES	CARBON	1 K		5% 1/4W	OHMITE	RC07GF102J
R05	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R06	010705	RES	METAL	4.53 K		1% T-0	IRC	RN55D4531F
R07	000910	RES	CARBON	91 OHM		5% 1/4W	OHMITE	RC07GF910J
R08	000470	RES	CARBON	47 OHM		5% 1/4W	OHMITE	RC07GF470J
R09	000152	RES	CARBON	1.5 K		5% 1/4W	OHMITE	RC07GF152J
R10	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R11	000470	RES	CARBON	47 OHM		5% 1/4W	OHMITE	RC07GF470J
R12	000222	RES	CARBON	2.2 K		5% 1/4W	OHMITE	RC07GF222J
R13	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R14	000222	RES	CARBON	2.2 K		5% 1/4W	OHMITE	RC07GF222J
R15	000152	RES	CARBON	1.5 K		5% 1/4W	OHMITE	RC07GF152J
R16	001758	RES	CARBON	330 OHM		5% 1 W	OHMITE	RC32GF331J
R17	040114	RES	VARI	50 K		10%	BECKMAN	62PR50
R18	000910	RES	CARBON	91 OHM		5% 1/4W	OHMITE	RC07GF910J
R19	000470	RES	CARBON	47 OHM		5% 1/4W	OHMITE	RC07GF470J
R20	040123	RES	VARI	1 K			BECKMAN	62PR1K
R21	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R22	010705	RES	METAL	4.53 K		1% T-0	IRC	RN55D4531F
R23	000102	RES	CARBON	1 K		5% 1/4W	OHMITE	RC07GF102J
R24	010720	RES	METAL	9.09 K		.25%	IRC	RN55C
R25	000203	RES	CARBON	20 K		5% 1/4W	OHMITE	RC07GF203J
R26	010704	RES	METAL	1 K		1% T-0	IRC	RN55D1001F
R27	010630	RES	METAL	9.09 K		1%	IRC	RN55D9091F

PARTS LIST

ASSEMBLY 406148 – SIGNAL COND (SINGLE CHANNEL)

REF DES	PART NO.	DESCRIPTION					
R28	000682	RES	CARBON	6.8 K	5% 1/4W	OHMITE	RC07GF682J
R29	000682	RES	CARBON	6.8 K	5% 1/4W	OHMITE	RC07GF682J
R30	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R31	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R32	000203	RES	CARBON	20 K	5% 1/4W	OHMITE	RC07GF203J
R33	010705=	RES	METAL	4.53 K	1% T-0	IRC	RN55D4531F
R34	040212	POT		25 K		CTS	UPE200-25K
R35	000391	RES	CARBON	390 OHM	5% 1/4W	OHMITE	RC07GF391J
R36	000241	RES	CARBON	240 OHM	5% 1/4W	OHMITE	RC07GF241J
R37	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R38	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J

PARTS LIST

ASSEMBLY 406580 – REAR PANEL

REF DES	PART NO.	DESCRIPTION					
F101	920364	FUSE		1 AMP		LITTLEFUSE	313001
J101	600619	CONN	RECPTLE		AC POWER	SWITCHCRAFT	EAC-301
J102	600567	CONN				AMPHENOL	31-236-1050
J103	600567	CONN				AMPHENOL	31-236-1050
J104	600567	CONN				AMPHENOL	31-236-1050
J105	600567	CONN				AMPHENOL	31-236-1050
J106	600567	CONN				AMPHENOL	31-236-1050
J111	600586	BNDNG	POST	WHITE		NOBEX	820-25
J112	600587	BNDNG	POST	BLK		NOBEX	820-45
J110	600589	BNDNG	POST	RED		NOBEX	820-65
P01	600566	CONN				CINCH	251-06-30-160
Q101	200155	TRANS				MOTOROLA	MJE520
Q102	200130	TRANS				MOTOROLA	MJE3055
Q103	200154	TRANS				MOTOROLA	MJE370
S101	600680	SWITCH	SLIDE			CW	GF-124
T101	300065	TRANSFORMER				AZTEC	11824

PARTS LIST

ASSEMBLY 406128 - PCB, INTERCONNECTION A

REF. DESIG.	PART NO.	DESCRIPTION		
P02	600575	CONN	25 PIN	CINCH 252-25-30-160
P04	600575	CONN	25 PIN	CINCH 252-25-30-160

PARTS LIST

ASSEMBLY 406630 – PCB, SWITCH

REF DES	PART NO.	DESCRIPTION						
C01	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C02	100069	CAP	CERAM	20 PFD	1000 V	20%	SPRAGUE	C023B102E220M
C03	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C06	100003	CAP	CERAM	3.3 PFD			CENTRALAB	DD3R3
C07	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C08	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C09	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C10	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C11	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C12	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C13	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C14	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C15	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C27	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C28	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C29	110104	CAP	TANT	4.7 UF	10 V	10%	KEMET	K4R7C10K
C31	100068	CAP	CERAM	.02 MFD	100 V	20%	SPRAGUE	TG-S20
C32	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C35	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C36	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C37	100053	CAP	DISC	56 PFD	1000 V	5%	SPRAGUE	10TCC-Q56
C38	100051	CAP		3 PFD			TCD	B1-0
C39	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C40	100050	CAP					SPRAGUE	10TCC-V22
C41	100060	CAP					SPRAGUE	10TCC-Q15
C42	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C44	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C45	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C46	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C47	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C48	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C49	110151	CAP		10 MFD	25 V		ITT	43212-16210
C50	110151	CAP		10 MFD	25 V		ITT	43212-16210
C51	101145	CAP	CERAM	100 PFD	500 V	10%	AEROVOX	SCD1X5F
C52	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10

PARTS LIST

ASSEMBLY 406630 – PCB, SWITCH

REF DES	PART NO.	DESCRIPTION						
C53	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C54	101145	CAP	CERAM	100 PFD	500 V	10%	AEROVOX	SCD1X5F
CR01	211083	DIODE	SILICO		018		DANA	211083
CR02	211083	DIODE	SILICO		018		DANA	211083
CR03	211083	DIODE	SILICO		018		DANA	211083
CR04	211083	DIODE	SILICO		018		DANA	211083
CR05	211083	DIODE	SILICO		018		DANA	211083
CR06	211083	DIODE	SILICO		018		DANA	211083
CR07	211083	DIODE	SILICO		018		DANA	211083
CR08	211083	DIODE	SILICO		018		DANA	211083
CR09	211083	DIODE	SILICO		018		DANA	211083
CR10	211083	DIODE	SILICO		018		DANA	211083
CR11	211083	DIODE	SILICO		018		DANA	211083
CR12	211083	DIODE	SILICO		018		DANA	211083
CR13	211083	DIODE	SILICO		018		DANA	211083
CR14	211083	DIODE	SILICO		018		DANA	211083
CR18	211083	DIODE	SILICO		018		DANA	211083
CR19	211083	DIODE	SILICO		018		DANA	211083
CR20	211083	DIODE	SILICO		018		DANA	211083
CR35	211083	DIODE	SILICO		018		DANA	211083
CR36	211083	DIODE	SILICO		018		DANA	211083
CR37	211083	DIODE	SILICO		018		DANA	211083
CR38	211083	DIODE	SILICO		018		DANA	211083
CR39	211083	DIODE	SILICO		018		DANA	211083
CR40	211083	DIODE	SILICO		018		DANA	211083
CR41	211083	DIODE	SILICO		018		DANA	211083
L01	310062	CHOKE		22 UH			DELEVAN	1537-44
L02	310072	INDUCTOR		2.20 UH			DELEVAN	1537-20
MA0	230028	INTEGRATED CIRCUIT					TI	SN7400N
MA02	230064	INTEGRATED CIRCUIT					TI	SN7404N
MA08	230099	INTEGRATED CIRCUIT					TI	SN7454N
MA09	230037	INTEGRATED CIRCUIT					TI	SN7490N
MA10	230037	INTEGRATED CIRCUIT					TI	SN7490N
MB08	230064	INTEGRATED CIRCUIT					TI	SN7404N
MB09	230037	INTEGRATED CIRCUIT					TI	SN7490N

PARTS LIST

ASSEMBLY 406630 – PCB, SWITCH

REF DES	PART NO.	DESCRIPTION		
MB10	230037	INTEGRATED CIRCUIT	TI	SN7490N
MC02	230064	INTEGRATED CIRCUIT	TI	SN7404N
MC05	230079	INTEGRATED CIRCUIT	TI	SN74H00N
MC06	230028	INTEGRATED CIRCUIT	TI	SN7400N
MC08	230099	INTEGRATED CIRCUIT	TI	SN7454N
MC09	230037	INTEGRATED CIRCUIT	TI	SN7490N
MC10	230037	INTEGRATED CIRCUIT	TI	SN7490N
MD01	230039	INTEGRATED CIRCUIT	MOTOROLA	MC1023P
MD02	230097	INTEGRATED CIRCUIT	MOTOROLA	MC1034P
MD03	230096	INTEGRATED CIRCUIT	MOTOROLA	MC1032P
MD04	230048	INTEGRATED CIRCUIT	MOTOROLA	MC1027P
MD05	230030	INTEGRATED CIRCUIT	TI	SN7402N
MD06	230064	INTEGRATED CIRCUIT	TI	SN7404N
MD07	230028	INTEGRATED CIRCUIT	TI	SN7400N
MD08	230064	INTEGRATED CIRCUIT	TI	SN7404N
MD09	230037	INTEGRATED CIRCUIT	TI	SN7490N
MD10	230037	INTEGRATED CIRCUIT	TI	SN7490N
ME02	230072	INTEGRATED CIRCUIT	TI	SN7474N
ME03	230081	INTEGRATED CIRCUIT	MOTOROLA	MC3060P
ME04	230032	INTEGRATED CIRCUIT	TI	SN7420N
ME05	230028	INTEGRATED CIRCUIT	TI	SN7400N
ME06	230028	INTEGRATED CIRCUIT	TI	SN7400N
ME07	230030	INTEGRATED CIRCUIT	TI	SN7402N
ME08	230032	INTEGRATED CIRCUIT	TI	SN7420N
ME09	230064	INTEGRATED CIRCUIT	TI	SN7404N
ME10	230037	INTEGRATED CIRCUIT	TI	SN7490N
MF03	230028	INTEGRATED CIRCUIT	TI	SN7400N
MF04	230028	INTEGRATED CIRCUIT	TI	SN7400N
MF05	230031	INTEGRATED CIRCUIT	TI	SN7410N
MF06	230028	INTEGRATED CIRCUIT	TI	SN7400N
MF07	230028	INTEGRATED CIRCUIT	TI	SN7400N
MF08	230099	INTEGRATED CIRCUIT	TI	SN7454N
MF09	230072	INTEGRATED CIRCUIT	TI	SN7474N
MF10	230028	INTEGRATED CIRCUIT	TI	SN7400N
Q02	200099	TRANS	TI	2N4258

PARTS LIST

ASSEMBLY 406630 – PCB, SWITCH

REF DES	PART NO.	DESCRIPTION						
Q03	200099	TRANS					TI	2N4258
Q04	200099	TRANS					TI	2N4258
Q05	200099	TRANS					TI	2N4258
Q06	200099	TRANS					TI	2N4258
Q07	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
Q09	200088	TRANS	SILICO	PNP	2N4248		FAIRCHILD	2N4248
Q10	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
Q19	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
Q20	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
Q21	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
Q22	200037	TRANS	SILICO	NPN	2N3646		FAIRCHILD	2N3646
R07	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R08	000471	RES	CARBON	470 OHM		5% 1/4W	OHMITE	RC07GF471J
R09	000222	RES	CARBON	2.2 K		5% 1/4W	OHMITE	RC07GF222J
R10	000621	RES	CARBON	620 OHM		5% 1/4W	OHMITE	RC07GF621J
R11	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R12	000240	RES	CARBON	24 OHM		5% 1/4W	OHMITE	RC07GF240J
R13	000750	RES	CARBON	75 OHM		5% 1/4W	OHMITE	RC07GF750J
R17	000821	RES	CARBON	820 OHM		5% 1/4W	OHMITE	RC07GF821J
R18	000511	RES	CARBON	510 OHM		5% 1/4W	OHMITE	RC07GF511J
R19	000112	RES	CARBON	1.1 K		5% 1/4W	OHMITE	RC07GF112J
R20	000621	RES	CARBON	620 OHM		5% 1/4W	OHMITE	RC07GF621J
R21	000621	RES	CARBON	620 OHM		5% 1/4W	OHMITE	RC07GF621J
R22	000301	RES	CARBON	300 OHM		5% 1/4W	OHMITE	RC07GF301J
R23	000391	RES	CARBON	390 OHM		5% 1/4W	OHMITE	RC07GF391J
R24	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R25	000301	RES	CARBON	300 OHM		5% 1/4W	OHMITE	RC07GF301J
R26	000242	RES	CARBON	2.4 K		5% 1/4W	OHMITE	RC07GF242J
R27	000182	RES	CARBON	1.8 K		5% 1/4W	OHMITE	RC07GF182J
R28	000391	RES	CARBON	390 OHM		5% 1/4W	OHMITE	RC07GF391J
R29	000101	RES	CARBON	100 OHM		5% 1/4W	OHMITE	RC07GF101J
R30	000750	RES	CARBON	75 OHM		5% 1/4W	OHMITE	RC07GF750J
R31	000240	RES	CARBON	24 OHM		5% 1/4W	OHMITE	RC07GF240J
R32	000750	RES	CARBON	75 OHM		5% 1/4W	OHMITE	RC07GF750J
R33	000240	RES	CARBON	24 OHM		5% 1/4W	OHMITE	RC07GF240J

PARTS LIST

ASSEMBLY 406630 – PCB, SWITCH

REF DES	PART NO.	DESCRIPTION					
R35	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R36	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R37	000182	RES	CARBON	1.8 K	5% 1/4W	OHMITE	RC07GF182J
R40	000222	RES	CARBON	2.2 K	5% 1/4W	OHMITE	RC07GF222J
R41	000222	RES	CARBON	2.2 K	5% 1/4W	OHMITE	RC07GF222J
R60	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R61	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R62	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R66	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R67	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R68	000123	RES	CARBON	12 K	5% 1/4W	OHMITE	RC07GF123J
R69	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R72	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R73	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R74	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R75	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R76	000302	RES	CARBON	3 K	5% 1/4W	OHMITE	RC07GF302J
R78	000471	RES	CARBON	470 OHM	5% 1/4W	OHMITE	RC07GF471J
R79	000302	RES	CARBON	3 K	5% 1/4W	OHMITE	RC07GF302J
R80	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R81	000821	RES	CARBON	820 OHM	5% 1/4W	OHMITE	RC07GF821J
R83	000821	RES	CARBON	820 OHM	5% 1/4W	OHMITE	RC07GF821J
R84	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R86	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R89	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R90	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R91	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R92	000122	RES	CARBON	1.2 K	5% 1/4W	OHMITE	RC07GF122J
R93	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R94	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R95	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R96	000201	RES	CARBON	200 OHM	5% 1/4W	OHMITE	RC07GF201J
R97	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R98	000302	RES	CARBON	3 K	5% 1/4W	OHMITE	RC07GF302J
R99	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J

PARTS LIST

ASSEMBLY 406630 – PCB, SWITCH

REF DES	PART NO.	DESCRIPTION						
R100	000153	RES	CARBON	15 K	5% 1/4W	OHMITE	RC07GF153J
R101	000302	RES	CARBON	3 K	5% 1/4W	OHMITE	RC07GF302J
R102	000302	RES	CARBON	3 K	5% 1/4W	OHMITE	RC07GF302J
R103	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R108	000301	RES	CARBON	300 OHM	5% 1/4W	OHMITE	RC07GF301J
R109	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R110	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R111	000122	RES	CARBON	1.2 K	5% 1/4W	OHMITE	RC07GF122J
R112	000162	RES	CARBON	1.6 K	5% 1/4W	OHMITE	RC07GF162J
R113	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R114	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R116	000113	RES	CARBON	11 K	5% 1/4W	OHMITE	RC07GF113J
R117	000470	RES	CARBON	47 OHM	5% 1/4W	OHMITE	RC07GF470J
R126	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R127	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R128	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R129	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R130	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R131	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R132	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R133	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R134	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R135	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R136	000153	RES	CARBON	15 K	5% 1/4W	OHMITE	RC07GF153J
R137	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
Y01	920583	CRYSTAL		9998.800 KHz		DANA	920583

PARTS LIST

ASSEMBLY 406145/146 – READOUT

REF DES	PART NO.	DESCRIPTION						
C01	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C05	110131	CAP		20 MFD	450 V		SPRAGUE	39D206F450GL4
C07	110146	CAP		5000 MFD	10 V	20%	SPRAGUE	39D508G010HP4
C08	110062	CAP	ELECT	500 MFD	50 V		SPRAGUE	39D507G050L4
C09	110062	CAP	ELECT	500 MFD	50 V		SPRAGUE	39D507G050L4
C10	101641	CAP	CERAM	470 PFD	500 V	10%	AEROVOX	SCD1X5F
CR01	211083	DIODE	SILICO		018		DANA	211083
CR02	211083	DIODE	SILICO		018		DANA	211083
CR03	211083	DIODE	SILICO		018		DANA	211083
CR04	211083	DIODE	SILICO		018		DANA	211083
CR05	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR06	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR07	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR08	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR11	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR12	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR13	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR14	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR15	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR16	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR17	211083	DIODE	SILICO		018		DANA	211083
CR18	220007	DIODE	SILICO	ZENER	1N751		MOTOROLA	1N751
CR19	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR20	220015	DIODE	SILICO	ZENER	1N967B		MOTOROLA	1N967B
CR21	211083	DIODE	SILICO		018		DANA	211083
CR22	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR23	220015	DIODE	SILICO	ZENER	1N967B		MOTOROLA	1N967B
CR24	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR25	211083	DIODE	SILICO		018		DANA	211083
CR26	211083	DIODE	SILICO		018		DANA	211083
CR27	211083	DIODE	SILICO		018		DANA	211083
CR28	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR29	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR30	211083	DIODE	SILICO		018		DANA	211083
CR40	211083	DIODE	SILICO		018		DANA	211083

PARTS LIST

ASSEMBLY 406145/146 – READOUT

REF DES	PART NO.	DESCRIPTION		
D01	920602	NEON	BULB	SIGNALITE A1C-A
D02	920602	NEON	BULB	SIGNALITE A1C-A
D03	920602	NEON	BULB	SIGNALITE A1C-A
D04	920602	NEON	BULB	SIGNALITE A1C-A
D05	920602	NEON	BULB	SIGNALITE A1C-A
D06	920602	NEON	BULB	SIGNALITE A1C-A
D07	920602	NEON	BULB	SIGNALITE A1C-A
J02	600665	TERM BOARD PIN	.062 DIA	BEAD R62-3
MA07	230064	INTEGRATED CIRCUIT		TI SN7404N
MA08	230031	INTEGRATED CIRCUIT		TI SN7410N
MA09	230099	INTEGRATED CIRCUIT		TI SN7454N
MA10	230099	INTEGRATED CIRCUIT		TI SN7454N
MA11	230031	INTEGRATED CIRCUIT		TI SN7410N
MA12	230064	INTEGRATED CIRCUIT		TI SN7404N
MB07	230064	INTEGRATED CIRCUIT		TI SN7404N
MB08	230028	INTEGRATED CIRCUIT		TI SN7400N
MB09	230099	INTEGRATED CIRCUIT		TI SN7454N
MB10	230099	INTEGRATED CIRCUIT		TI SN7454N
MB11	230031	INTEGRATED CIRCUIT		TI SN7410N
MB12	230028	INTEGRATED CIRCUIT		TI SN7400N
MC01	230064	INTEGRATED CIRCUIT		TI SN7404N
MC02	230028	INTEGRATED CIRCUIT		TI SN7400N
MC03	230031	INTEGRATED CIRCUIT		TI SN7410N
MC07	230028	INTEGRATED CIRCUIT		TI SN7400N
MC08	230028	INTEGRATED CIRCUIT		TI SN7400N
MC09	230098	INTEGRATED CIRCUIT		TI SN7490N
MC10	230098	INTEGRATED CIRCUIT		TI SN7490N
MC11	230098	INTEGRATED CIRCUIT		TI SN7490N
MC12	230099	INTEGRATED CIRCUIT		TI SN7454N
MD02	230037	INTEGRATED CIRCUIT		TI SN7490N
MD03	230037	INTEGRATED CIRCUIT		TI SN7490N
MD04	230037	INTEGRATED CIRCUIT		TI SN7490N
MD05	230037	INTEGRATED CIRCUIT		TI SN7490N
MD06	230037	INTEGRATED CIRCUIT		TI SN7490N
MD07	230037	INTEGRATED CIRCUIT		TI SN7490N

PARTS LIST

ASSEMBLY 406145/146 – READOUT

REF DES	PART NO.	DESCRIPTION					
MD08	230037	INTEGRATED CIRCUIT				TI	SN7490N
MD10	230064	INTEGRATED CIRCUIT				TI	SN7404N
MD11	230028	INTEGRATED CIRCUIT				TI	SN7400N
MD12	230099	INTEGRATED CIRCUIT				TI	SN7454N
ME02	230065	INTEGRATED CIRCUIT				TI	SN7475N
ME03	230065	INTEGRATED CIRCUIT				TI	SN7475N
ME04	230065	INTEGRATED CIRCUIT				TI	SN7475N
ME05	230065	INTEGRATED CIRCUIT				TI	SN7475N
ME06	230065	INTEGRATED CIRCUIT				TI	SN7475N
ME07	230065	INTEGRATED CIRCUIT				TI	SN7475N
ME08	230065	INTEGRATED CIRCUIT				TI	SN7475N
ME09	230065	INTEGRATED CIRCUIT				TI	SN7475N
MF02	230034	INTEGRATED CIRCUIT				TI	SN7441N
MF03	230034	INTEGRATED CIRCUIT				TI	SN7441N
MF04	230034	INTEGRATED CIRCUIT				TI	SN7441N
MF05	230034	INTEGRATED CIRCUIT				TI	SN7441N
MF06	230034	INTEGRATED CIRCUIT				TI	SN7441N
MF07	230034	INTEGRATED CIRCUIT				TI	SN7441N
MF08	230034	INTEGRATED CIRCUIT				TI	SN7441N
MF09	230034	INTEGRATED CIRCUIT				TI	SN7441N
Q01	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q05	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q06	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q07	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q08	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q09	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q10	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q11	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q12	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q15	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q17	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q18	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q19	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q20	200087	TRANS	SILICO		021	MOTOROLA	SPS1226
Q21	200087	TRANS	SILICO		021	MOTOROLA	SPS1226

PARTS LIST

ASSEMBLY 406145/146 -- READOUT

REF DES	PART NO.	DESCRIPTION						
Q22	200087	TRANS	SILICO		021		MOTOROLA	SPS1226
Q23	200087	TRANS	SILICO		021		MOTOROLA	SPS1226
Q25	200052	TRANS	SILICO	PNP	009		DANA	200052
Q26	200022	TRANS	SILICO	PNP	012		DANA	200022
Q27	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q28	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
R01	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R02	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R03	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R04	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R05	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R06	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R07	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R08	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R10	000302	RES	CARBON	3 K		5% 1/4W	OHMITE	RC07GF302J
R11	000302	RES	CARBON	3 K		5% 1/4W	OHMITE	RC07GF302J
R12	000622	RES	CARBON	6.2 K		5% 1/4W	OHMITE	RC07GF622J
R15	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R16	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R17	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R18	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R19	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R20	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R21	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R22	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R23	000512	RES	CARBON	5.1 K		5% 1/4W	OHMITE	RC07GF512J
R24	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R26	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R28	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R30	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R32	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R34	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R36	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R39	000202	RES	CARBON	2 K		5% 1/4W	OHMITE	RC07GF202J
R40	000103	RES	CARBON	10 K		5% 1/4W	OHMITE	RC07GF103J

PARTS LIST

ASSEMBLY 406145/146 – READOUT

REF DES	PART NO.		DESCRIPTION				
R41	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R42	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R43	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R45	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R46	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R47	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R48	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R49	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R50	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R51	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R52	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R53	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R54	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R55	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R56	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R57	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R60	020620	RES	WW	3.9 K	5%	CF	M20
R61	000204	RES	CARBON	200 K	5% 1/4W	OHMITE	RC07GF204J
R62	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R63	001793	RES	CARBON	1 K	5% 1/2W		
R64	001765	RES		68 OHM	5% 1/2W	OHMITE	RC07GF680J
R65	000272	RES	CARBON	2.7 K	5% 1/4W	OHMITE	RC07GF272J
R66	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R67	000362	RES	CARBON	3.6 K	5% 1/4W	OHMITE	RC07GF362J
R68	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R69	000272	RES	CARBON	2.7 K	5% 1/4W	OHMITE	RC07GF272J
R70	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R71	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R72	000272	RES	CARBON	2.7 K	5% 1/4W	OHMITE	RC07GF272J
R73	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R74	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R75	000123	RES	CARBON	12 K	5% 1/4W	OHMITE	RC07GF123J
R76	000821	RES	CARBON	820 OHM	5% 1/4W	OHMITE	RC07GF821J
R77	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
V01	920506	TUBE	DISPLAY			AMPEREX	ZM1000

PARTS LIST

ASSEMBLY 406145/146 – READOUT

REF DES	PART NO.	DESCRIPTION			
V02	920506	TUBE	DISPLAY	AMPEREX	ZM1000
V03	920506	TUBE	DISPLAY	AMPEREX	ZM1000
V04	920506	TUBE	DISPLAY	AMPEREX	ZM1000
V05	920506	TUBE	DISPLAY	AMPEREX	ZM1000
V06	920506	TUBE	DISPLAY	AMPEREX	ZM1000
V07	920506	TUBE	DISPLAY	AMPEREX	ZM1000
V08	920506	TUBE	DISPLAY	AMPEREX	ZM1000
W03	600245	JUMPER		GETTIG	L-2007-1

PARTS LIST

ASSEMBLY 406563 – HARNESS, REMOTE & RECORDER

REF DES	PART NO.	DESCRIPTION	
J110	715091	PCB Finger Board, REMOTE	PCBF
J111	715092	PCB Finger Board, RECORD	PCBF
J112	715093	PCB Finger Board, RECORD	PCBF

PARTS LIST

ASSEMBLY 406120 – 500 MHz PRESCALER (50 mV)

REF DES	PART NO.	DESCRIPTION						
B01	920563	BEADS					FERX CBE	56-59065-4B
B02	920563	BEADS					FERX CBE	56-59065-4B
B03	406466	ASSY					DANA	406466
B04	406466	ASSY					DANA	406466
B05	406466	ASSY					DANA	406466
C01	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C02	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C03	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C04	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C05	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C06	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C07	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C08	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C09	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C10	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C11	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C12	100025	CAP	CERAM	.005 MFD	100 V	20%	ERIE	835-000-X5V0502Z
C13	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C14	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C15	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C16	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C17	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C18	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C19	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C20	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C21	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C22	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C23	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C24	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C25	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C26	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C27	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C28	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C29	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C30	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10

PARTS LIST

ASSEMBLY 406120 – 500 MHz PRESCALER (50 mV)

REF DES	PART NO.	DESCRIPTION						
C31	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C32	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C33	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C34	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C35	100009	CAP	CERAM	5 PFD	500 V	10%	AEROVOX	TCD-N750
C36	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C37	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C38	130103	CAP		10000 PFD			ERIE	A08AE9ACFW5R103M
C39	130104	CAP		1000 PFD			ERIE	A08AE9ACFW5R102M
C40	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C41	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C42	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C43	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C44	110001	CAP	TANTA	6.8 MFD	35 V	10%	KEMET	K6R8C35K
C45	110001	CAP	TANTA	6.8 MFD	35 V	10%	KEMET	K6R8C35K
C46	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C47	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C48	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C49	110001	CAP	TANTA	6.8 MFD	35 V	10%	KEMET	K6R8C35K
C50	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C51	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
CR01	210040	DIODE					MICROWAVE	MA47600
CR02	210040	DIODE					MICROWAVE	MA47600
CR03	210040	DIODE					MICROWAVE	MA47600
CR04	210004	DIODE	SILICO		SD4		DIODES, INC.	SD4
CR05	210040	DIODE					MICROWAVE	MA47600
CR06	211083	DIODE	SILICO		018		DANA	211083
CR07	211083	DIODE	SILICO		018		DANA	211083
CR08	210040	DIODE					MICROWAVE	MA47600
CR09	210026	DIODE	RF DET				MOTOROLA	1N82AG
CR10	210026	DIODE	RF DET				MOTOROLA	1N82AG
CR11	211083	DIODE	SILICO		018		DANA	211083
CR12	211083	DIODE	SILICO		018		DANA	211083
CR13	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		MOTOROLA	1/4M3.3AZ5

PARTS LIST

ASSEMBLY 406120 – 500 MHz PRESCALER (50 mV)

REF DES	PART NO.	DESCRIPTION					
CR14	211083	DIODE	SILICO		018	DANA	211083
CR15	211083	DIODE	SILICO		018	DANA	211083
CR16	210026	DIODE	RF DET			MOTOROLA	1N82AG
CR17	210004	DIODE	SILICO		SD4	DIODES, INC.	SD4
J12	600610	CONN	RECPTLE			SEALECTRO	50053-0000
J13	600610	CONN	RECPTLE			SEALECTRO	50053-0000
L01	310062	CHOKE		22 UH		DELEVAN	1537-44
L02	310062	CHOKE		22 UH		DELEVAN	1537-44
L03	310062	CHOKE		22 UH		DELEVAN	1537-44
L04	310062	CHOKE		22 UH		DELEVAN	1537-44
L05	310062	CHOKE		22 UH		DELEVAN	1537-44
L06	310062	CHOKE		22 UH		DELEVAN	1537-44
L07	310062	CHOKE		22 UH		DELEVAN	1537-44
L08	310081	CHOKE		.125 DIA		DANA	310081
L09	310099	CHOKE				DANA	310099
L10	310081	CHOKE		.125 DIA		DANA	310081
L11	310099	CHOKE				DANA	310099
L12	310081	CHOKE		.125 DIA		DANA	310081
L13	310081	CHOKE		.125 DIA		DANA	310081
L14	310092	CHOKE	RF	.1 UH		MILLER	9230-94
M01	230045	INTEGRATED CIRCUIT			UA741C	FAIRCHILD	UA741C
M02	230095	INTEGRATED CIRCUIT				MOTOROLA	MC1670L
P10	600593	CONN		6 PIN		CINCH	250-06-30-170
Q01	200035	TRANS	SILICO	NPN	014	DANA	200035
Q02	200011	TRANS	SILICO	PNP	009	DANA	200011
Q03	200151	TRANS				MOTOROLA	2N5179
Q04	200151	TRANS				MOTOROLA	2N5179
Q05	200176	TRANS				FAIRCHILD	SE3005
Q06	200151	TRANS				MOTOROLA	2N5179
Q07	200151	TRANS				MOTOROLA	2N5179
Q08	200151	TRANS				MOTOROLA	2N5179
Q09	200151	TRANS				MOTOROLA	2N5179
Q10	200151	TRANS				MOTOROLA	2N5179
Q11	200151	TRANS				MOTOROLA	2N5179
Q12	200151	TRANS				MOTOROLA	2N5179

PARTS LIST

ASSEMBLY 406120 – 500 MHz PRESCALER (50 mV)

REF DES	PART NO.	DESCRIPTION					
Q13	200151	TRANS				MOTOROLA	2N5179
Q14	200151	TRANS				MOTOROLA	2N5179
Q15	200151	TRANS				MOTOROLA	2N5179
Q16	200151	TRANS				MOTOROLA	2N5179
Q17	200151	TRANS				MOTOROLA	2N5179
Q18	200151	TRANS				MOTOROLA	2N5179
Q19	200151	TRANS				MOTOROLA	2N5179
Q20	200151	TRANS				MOTOROLA	2N5179
R01	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R02	001683	RES	CARBON	47 OHM	5% 1/2W	OHMITE	RC20GF470J
R03	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R04	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R05	001675	RES	CARBON	100 OHM	5% 1/2W	OHMITE	RC20GF101J
R06	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R07	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R08	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R09	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R10	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R11	001788	RES	CARBON	470 OHM	5% 1 W		
R12	000752	RES	CARBON	7.5 K	5% 1/4W	OHMITE	RC07GF752J
R13	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R14	030007	RES	CARBON	150 OHM	5% 3 W	OHMITE	4396
R15	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R16	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R17	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R18	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R19	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R20	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R21	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R22	000512	RES	CARBON	5.1 K	5% 1/4W	OHMITE	RC07GF512J
R23	000822	RES	CARBON	8.2 K	5% 1/4W	OHMITE	RC07GF822J
R24	000304	RES	CARBON	300 K	5% 1/4W	OHMITE	RC07GF304J
R25	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R26	000301	RES	CARBON	300 OHM	5% 1/4W	OHMITE	RC07GF301J
R27	000132	RES	CARBON	1.3 K	5% 1/4W	OHMITE	RC07GF132J

PARTS LIST

ASSEMBLY 406120 – 500 MHz PRESCALER (50 mV)

REF DES	PART NO.	DESCRIPTION					
R28	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R30	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R31	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R32	000752	RES	CARBON	7.5 K	5% 1/4W	OHMITE	RC07GF752J
R33	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R34	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R35	000751	RES	CARBON	750 OHM	5% 1/4W	OHMITE	RC07GF751J
R36	000510	RES	CARBON	51 OHM	5% 1/4W	OHMITE	RC07GF510J
R37	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R38	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R39	000682	RES	CARBON	6.8 K	5% 1/4W	OHMITE	RC07GF682J
R40	000150	RES	CARBON	15 OHM	5% 1/4W	OHMITE	RC07GF150J
R41	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R42	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R43	000471	RES	CARBON	470 OHM	5% 1/4W	OHMITE	RC07GF471J
R44	000391	RES	CARBON	390 OHM	5% 1/4W	OHMITE	RC07GF391J
R45	001787	RES	CARBON	20 OHM	5% 1/8W		
R46	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R47	000182	RES	CARBON	1.8 K	5% 1/4W	OHMITE	RC07GF182J
R48	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R49	001787	RES	CARBON	20 OHM	5% 1/8W		
R50	000391	RES	CARBON	390 OHM	5% 1/4W	OHMITE	RC07GF391J
R51	000391	RES	CARBON	390 OHM	5% 1/4W	OHMITE	RC07GF391J
R52	000240	RES	CARBON	24 OHM	5% 1/4W	OHMITE	RC07GF240J
R53	001787	RES	CARBON	20 OHM	5% 1/8W		
R54	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R55	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R56	000182	RES	CARBON	1.8 K	5% 1/4W	OHMITE	RC07GF182J
R57	000101	RES	CARBON	100 OHM	5% 1/4W	OHMITE	RC07GF101J
R58	001787	RES	CARBON	20 OHM	5% 1/8W		
R59	000823	RES	CARBON	82 K	5% 1/4W	OHMITE	RC07GF823J
R60	000391	RES	CARBON	390 OHM	5% 1/4W	OHMITE	RC07GF391J
R61	000270	RES	CARBON	27 OHM	5% 1/4W	OHMITE	RC07GF270J
R62	000362	RES	CARBON	3.6 K	5% 1/4W	OHMITE	RC07GF362J
R63	000151	RES	CARBON	150 OHM	5% 1/4W	OHMITE	RC07GF151J

PARTS LIST

ASSEMBLY 406120 – 500 MHz PRESCALER (50 mV)

REF DES	PART NO.	DESCRIPTION					
R64	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R65	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R66	000301	RES	CARBON	300 OHM	5% 1/4W	OHMITE	RC07GF301J
R67	000301	RES	CARBON	300 OHM	5% 1/4W	OHMITE	RC07GF301J
R68	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R69	000200	RES	CARBON	20 OHM	5% 1/4W	OHMITE	RC07GF200J
R70	000751	RES	CARBON	750 OHM	5% 1/4W	OHMITE	RC07GF751J

PARTS LIST

ASSEMBLY 406660 - 662 – REAR INPUT OPTION 010

REF DES	PART NO.	DESCRIPTION				
J107	406564	BNC CABLE ASSY			DANA	406564
J108	001803	RES	24 OHM	5% 1/8W		
J108	600567	CONN			AMPHENOL	31-236-1050
J109	001803	RES	24 OHM	5% 1/8W		
J109	600567	CONN			AMPHENOL	31-236-1050
J203	406520	ASSY			DANA	406520

www.manualsplus.com
1012985